VOLUME XLVI NUMBER 1

INDIAN FORESTER

JANUARY 1920.

BRIEF NOTE ON THE ARTIFICIAL RAISING OF SANDAL IN THE AKOLA DIVISION OF THE BERAR CIRCLE, CENTRAL PROVINCES.

Introduction.

While I was on deputation in Mysore from 1907 to 1911, I had a unique opportunity for studying in its *habitat* the natural growth of sandal and the comparative merits of the various artificial methods employed recently and in the past to increase its stock in the Province, and this led me to take some interest in sandal culture.

When I reverted to the British service in the early part of 1912, I was posted to the charge of the Akola Division where I have since been. In the course of a brief and rapid tour through the district, soon after joining, I happened to see a few sandal trees in some private lands and in two or three adjoining Government forests, and this led me to conclude that suitable localities in the scrub jungles of the district might be found where sandal-seed

could be dibbled under bushes and clusters of stunted and shady trees.

But before I set about this pleasant work, I was anxious to find out if the trees growing in Berar produced scented wood, and to this end I had a half dead small tree, standing in garden land, cut and examined in order to be sure that my labour would not be in vain, and was pleased to find that it did contain good scented heartwood, not much inferior to that produced in Mysore. Encouraged by this, I indented for a bag of the Mysore indigenous sandal-seed in the summer of 1912, and having personally selected a few suitable localities, instructed the local forest subordinates to have it dibbled there under shady, protecting and nursing bushes in the beginning of the following rains.

Physical description of the district.

Akola is a very dry district, being situated between latitudes 21° 16′ and 19° 51′ S., and longitudes 77° 44′ and 76° 38′ W., with an average rainfall of 26 inches, the rainy days not being more than 45 in the year. We have long spells of dry and hot weather (temperature rising to 116° in May) being, however, redeemed by occasional showers and hail-storms in the months of January to April. This redeeming feature is generally favourable to jungle tree growth and particularly to sandal in this country.

The chief forests of the Division, which consist of stunted teak and miscellaneous scrub occupying an area of 185 square miles, are confined to the range of low hills running across the district, east and west, broken up by numerous wide and shallow valleys, while in other parts are to be seen, widely scattered, about small isolated babul bans, grass reserves and grazing grounds, the two latter aggregating 128 square miles.

The general elevation of the plain portion of the district is from 900 to 1,100 feet above sea-level, that of the tableland being 400 to 600 feet higher.

Deccan trap covers the entire district, the underlying rock being hard grey basalt with softer varieties of trap. The soil resulting from the disintegration of these is generally light reddish-brown clay varying in depth and porosity from place to place.

Fig. 1.—Showing a fine group of 3 to 5 year old sandal saplings growing in association with stunted Mohwa (*Bassia latifolia*), *Terminalia tomentosa*, *Odina Wodier*, Khair, Palas, etc., in the ideal Deodari plot. The men are standing between the saplings.

Photo.-Mechl. Dept., Thomason College, Roorkee. Photos by B. I. Shama Rao.

Fig. 2. Showing a small babul tree artificially raised in 1913-14 in S. No. 26 of Khudad cultivated under agri-sylvicultural method and three 3 to 4 year-old saplings and 3 young seedlings of Sandal which have spontaneously come up under it. The seedlings are marked at their bases with lime-splashed bricks.

Short history of sandal, its natural growth and artificial means of raising it.

The home of sandal in India may be said to be the State of Mysore where its excellent growth is to be seen at elevations ranging from 2,000 to 3,000 feet with a rainfall of from 40 to 70 inches. It is not known if sandal grows anywhere outside India, and the major portion of the world's requirements of sandal-wood and essential oil are supplied from Mysore.

Sandal generally thrives on laterite (red ferruginous) soil and well-drained sandy loam on the lower slopes of hills and sheltered low-lying lands bearing bushes or scrubby growth of miscellaneous species such as—

Elæodendron Roxburghii, Anogeissus latifolia, Bassia latifolia, Morinda exserta, Mangifera indica, Grewia tiliæfolia, Zizyphus Œnoplia, Cassia auriculata, Albizzia odoratissima, Teak, *Lantana camara* and other species named in column 5 of the list of measurements attached.

The best scented wood is obtained from slow-grown trees on soils of medium quality. It is shade-enduring, evergreen, tenacious and hardy and, being of a parasitic tendency, requires the aid of "hosts," as they are technically called, to grow to any advantage.

Fig. No. 1 illustrates sandal plants and saplings growing with the aid of hosts.

It produces itself from root-suckers as well as from self-sown seed and by these means it rapidly spreads into areas congenial to it.

No elaborate and expensive nurseries for raising sandal plants nor subsequent transplantings are ever needed. The seed is sown *in situ* in the forest at carefully selected points under protecting and nursing bushes where the sandal trees are to remain permanently. It is noteworthy that even in self-sown areas sandal seedlings are invariably found growing in close association with other trees or under bushes.

Fig. No. 2 shows natural sandal saplings growing under cover of a young babul tree artificially raised in a clear-felled and cultivated area under the agri-sylvicultural method.

This establishes the fact that sandal must have nurses and associates of a permanent character.

The dibbling operation is not at all expensive. A cooly earning from 5 to 6 annas a day can easily make 50 to 60 patches *well under bushes* and put in from 2 to 3 seeds in shallow holes at different points in each and cover them up with loose earth. The number of patches that can be made under a bush depends upon its size. Under a big and wide spreading bush or a cluster of trees there may be as many as ten patches. But no patches should ever be made along the outer edge of the bush. In a month or six weeks the seeds will have germinated. In Akola it has been observed that germination generally begins in about 21 days and will be complete in about two weeks thereafter. Some of the seeds found to lie dormant in a year of scanty rainfall or insufficient moisture in the soil during the germination period have been observed to germinate in the following season. These, however, are rare exceptions. Seeds do not generally keep their vitality long after one year and much less in the case of those that have to lie underground exposed to the attacks of insects and worms and pass through all the seasons of a year. It is, therefore, essential that fresh mature-seeds should be secured for dibbling if any appreciable *measure of success is to be ensured.* Dense, tall and tangled growth of grass in the sandal area is inimical to the young plants.

No after-care or tending of the seedlings or saplings is necessary beyond freeing their leading shoots where absolutely needed to enable them to work up through any obstructing cover ; neither is any weeding required. It is remarkable that sandal plants growing comfortably under bushes work their way up through their crowns generally without any artificial aid.

Fig. No. 3 shows a natural sandal sapling working its way up through the crown of a babul tree under which it is growing.

Fig. No. 4 shows the tallest of the 6½ year old sandal trees.

The young plants come up and if, perchance, their tender shoots are nipped off by rats, squirrels or insects against which there does not seem to be any practical defence, fresh leaders are

Photo.-Mechl. Dept., Thomason College, Roorkee.

Fig. 3.—Showing a group of natural sandal saplings and seedlings growing under and in association with babul (*Acacia arabica*) Hiwar (*Acacia leucophlaea*) Hingan (*Balanites Roxburghii*) etc. in S. No. 28 of Khudad. Young sandal seedlings are marked with lime-splashed bricks. Note a sapling having worked its way up through the babul crown without any artificial aid.

Photos by B. I. Shama Rao.

Fig. 4.—Showing the tallest of the $6\frac{1}{2}$ year-old small sandal trees found in our artificial plots in the Division.
Girth 13 inches. Height 25 feet.

formed in the growing season, so great is their recuperative power.

In this way such plants as live through all the seasons of a normal year or two indifferent ones in this country, where the climatic conditions are different from those obtaining in Mysore, will not die afterwards, and we may hopefully count upon their attaining maturity and reproducing both from their roots and seeds myriads of young ones thus adding to the material value of the forest which they may grace by their existence. Under the cover of a small sandal tree of about 12 inches girth and over 20 feet in height I observed quite a number of young seedlings and root-suckers. This shows the natural tendency of sandal to propagate and spread its kind where climatic circumstances and environments are favourable.

Small isolated areas near Yeota and Khudad in the Murtizapur Taluq are splendid examples of what nature can do to propagate and spread sandal introduced artificially in a suitable locality. Seedlings, saplings and small trees of all sizes up to $2\frac{3}{4}$ feet girth are represented here.

The existence of naturally growing sandal to an appreciable extent in any particular locality is an infallible indication that this most valuable species can grow to advantage if artificially introduced in identical plots.

Now coming to the work actually done in this direction in the Akola Division in the past six years it is gratifying to note that in the aggregate an area of approximately 790 acres has been stocked with artificially-raised young sandal seedlings and small trees, good samples of which may be seen in the ideal Deodari plot as well as elsewhere.

The following is a rough list of the areas operated on and of the plants that exist in each :—

Detailed list of areas operated on during the period from 1912 to 1916 and of the plants that exist in each and expenditure incurred.

Division	Range	Name of plot	Approximate area in acres.	Expenditure incurred.	Approximate number of small trees, saplings, seedlings now living.	REMARKS.
	1	2	3	4	5	6
AKOLA.	Balapur ...	Total ...	400	330	44,300	The sowings done on a large scale in the rains of 1918 were greatly disappointing owing to extremely scanty rainfall. The figures given in column No. 5 include sandal trees down to 18 months old plants, *i.e.*, those raised in 1917. It is quite possible that there are a few thousands more sandal seedlings than the number stated in column No. 5.
	Morna ...	Deodari ...	50	...	4,500	
		Sakarwihir ...	10	...	600	
		Selgaon ...	32	...	4,000	
		Bormali ...	50	...	1,500	
		Janoona ...	50	...	3,500	
		Rajankheda ...	2	120	200	
		Dhaba ...	1	...	300	
		Petra ...	5	...	1,000	
		Dhanora ...	12	...	20	
		Dotarkheda ...	9	...	90	
		Shahnur ...	4	...	400	
		Total ...	225	120	16,110	
	Pangra ...	Pur ...	5	...	500	
		Andharsaongi ...	5	...	200	
		Tapowan ...	10	...	100	
		Mohoja ...	5	170	70	
		Bibikhora ...	40	...	6,000	
		Mohisdari ...	55	...	5,700	
		Total ...	120	170	14,570	
	Murtizapur ...	*Injha ...	3	...	20	* These are natural sandal plots in which hundreds of healthy and promising small trees, saplings, and seedlings exist.
		Yeota ...	25	41	...	
		*Khodad ...	17	...	...	
		Total ...	45	41	20	
	Add cost and carriage of seed ...		...	165	...	
		Total ...		166	...	
		Grand Total ...	790	837	75,000	

Throughout this period Mysore seed was obtained for dibbling. Only on two occasions was a small quantity of seed obtained from the Salem District in addition.

As the season of 1918 was exceptionally bad owing to short rainfall, in places not amounting to more than 10″, the dibbling work carried out then was not very successful. Still I expect that some of the seeds lying dormant under-ground will germinate in the next rains.

A few measurements of sandal seedlings and saplings taken for different years in artificial and natural sandal plots will be interesting :—

Year.	Name of plot.	Serial No.	Approximate height. F.	Approximate height. I.	Girth at 4 feet from the ground. F.	Girth at 4 feet from the ground. I.	Associated species.	REMARKS.
...	Yeota in Murtizapur Taluq. (Natural sandal plot.)	1	30	0	2	10	*Mangifera indica, Dalbergia Sissoo, Bambusa arundinacea, Cordia Myxa, Melia Azederach, Eugenia Jambolana, etc.*	In the past 20 years sandal has been naturally spreading in the area, small trees, saplings and seedlings of all ages being represented.
		2	22	0	2	7		
		3	29	0	2	8		
		4	22	0	2	4		
		5	20	0	1	11		
		6	31	0	1	10		
		7	21	0	1	10		
		8	21	0	1	8		
		9	22	0	1	6		
		10	20	0	1	4		
		11	18	0	1	2		
		12	14	0	0	11		
1912	Deodari S. No 52. Area 23 acres. Portion of this is stocked with sandal. (Artificial sandal plot.)	1	19	0	1	3	*Butea frondosa, Gymnosporia montana, Randia dumetorum, Diospyros melanoxylon, Buchanania latifolia, Odina Wodier, Acacia Catechu, Lagerstrœmia parviflora, etc.*	An ideal sandal plot.
		2	17	0	1	1		
		3	15	0	0	11		
		4	14	0	0	10		
		5	18	0	0	9		
		6	15	0	0	8		
		7	15	0	0	7		
		8	10	3	0	7		
1913	Deodari. Area comprising S. Nos. 37, 38, 45, 46, 49 and 57 aggregating to 56 acres.	1	16	0	0	8½	Ditto.	
		2	15	0	0	6		
		3	12	0	0	4		
		4	12	0	0	3		
		5	8	6	0	2		

Year.	Name of plot.	Serial No.	Approximate height. F.	Approximate height. I.	Girth at 4 feet from the ground. F.	Girth at 4 feet from the ground. I.	Associated species.	REMARKS.
1914	Deodari ...	1	14	0	0	8½		
		2	15	0	0	7		
		3	14	0	0	6		
		4	15	6	0	5		
		5	13	0	0	4		
		6	10	0	0	3		
1915	Deodari ...	1	8	6	0	2½	*Butea frondosa, Gymnosporia montana, Randia dumetorum, Diospyros melanoxylon, Buchanania latifolia, Odina Wodier, Acacia Catechu, Lagerstrœmia parviflora, etc.*	
		2	10	0	0	2		
		3	6	6	0	2		
		4	10	0	0	1¾		
		5	11	0	0	1¾		
		6	9	6	0	1½		
		7	6	0	0	1½		
		8	11	6	0	1½		
		9	11	0	0	1½		
		10	8	6	0	1½		
1916	Deodari ...	1	5	6	0	1¾		
		2	6	0	0	1½		
		3	5	0	0	1½		
		4	6	0	0	1½		
		5	4	6	0	1¼		
		6	7	6	0	1¼		
		7	5	6	0	1		
		8	8	0	0	1		
		9	5	3	0	1		
		10	5	6	0	1		
...	Khodad (natural sandal plot).	1	26	0	1	10	*Acacia arabica, Balanites Roxburghii, Acacia leucophlœa, Khair, etc.*	
		2	22	0	1	7		
		3	25	0	1	4		
		4	21	0	1	2		
		5	20	0	1	0		
		6	18	0	0	10		
		7	15	0	0	8		
		8	12	0	0	6		

Note.—Besides these there are hundreds of young saplings and seedlings. In the past 20 years, sandal has been naturally spreading in the area, small trees, saplings and seedlings of all ages being represented.

If the thousands of seedlings and saplings mentioned in the above rough list survive for a sufficient number of years and grow up to maturity, their exploitation is sure to bring in considerable revenue compared with the very small *initial* expenditure, *viz.*, Rs. 827 incurred during the said period of six years in raising the valuable crop and *absolutely without any cost* on subsequent upkeep.

Looking at the past six years' highly encouraging results it is certainly worth while spending a small amount annually for a few more years in getting Mysore seed and sowing it in suitable places here. When the locally-grown trees begin to yield good seed, then we may stop indenting on Mysore for it. After the first decade we shall have natural regeneration from self sown seeds and root-suckers and thus the stock of sandal will go on increasing year after year. Artificial sowings wherever desired to supplement the natural process can be easily carried out with the seed obtained locally.

General Remarks.

I believe it will not be out of place to say a few words here regarding the great importance and high value of sandalwood. Sandalwood in Mysore in former years used to be sold at an *average* rate of Rs. 500 per ton. In the year 1916 the highest price obtained at the Mysore Sandal "Kotis" (Depôts) was over Rs. 1,200 per ton. About four years ago the Mysore Government started Factories equipped with up-to-date machinery and appliances in Mysore and Bangalore to extract essential oil from Sandalwood exploited in the Province and stopped selling the wood. The oil distilled at these Factories is said to yield a revenue of 30 lakhs which is nearly double that which used to be obtained from the sale of the wood.

The comparative qualities and values of the heartwood extracted from mature trees grown in this country and from those grown in Mysore may be ascertained in due course scientifically for commercial and economic purposes when we have produced a sufficient stock of it. In the cold season of 1916-17 when Mr. Hill, our Chief Conservator, was inspecting the sandal

plots in a long tour specially arranged for the purpose, I demonstrated to him the comparative merits of the two woods by physical tests, I had then with me some billets obtained from Mysore and some pieces from a tree that had been cut at the edge of a field in the village of Alegaon in the Akola District. They did not show much difference in scent or structure. In the yield and quality of essential oil possibly there may be some slight difference which scientific tests alone can determine. But at this stage we need not trouble ourselves about it or allow our enthusiasm for raising sandal here to be damped by any discussion over the question. In the face of these facts which have been elicited by my personal study and critical examination of the comparative merits of the Berar and Mysore sandal woods, I feel it to be impossible to agree with Mr. D. O. W tt's remarks under serial No. 295 on page 69 of his Berar Flora that "sandal does not appear to thrive well in Berar, the wood being almost scentless."

I hope the above note will be of some practical use to those of the Department, who may wish to introduce this most valuable species into their forests

MYSORE : } B. V. RAMA RAO,

28th May 1919. } *P. F. S.*

AEROPLANES AND FORESTS.

It is proposed to treat of their relations under the following headings :—

(1) Survey.

(2) Protection.

(3) Utilization.

During the war one of the most important, if not the most important, duty of the flying arm has been survey work. This was done by photography. Let us consider a certain section of the line. In the Struma valley there were practically no accurate maps,

Survey.

and the only line whose position was accurately known was the railway line. There were maps on which this was accurately marked. This railway was almost exclusively in the hands of the enemy. For the purposes of General Headquarters it was necessary to have a good detailed map of both sides of the lines. This was largely obtained by the flying people as far as concerned the territory held by the enemy. Certain points such as the above railway line were taken as base lines. Prominent features such as minarets in villages were fixed by careful observation with theodolite from our side of the line. The machines then went over and flew over a fixed mark, and to a fixed mark, if possible, taking photos. It was necessary to have at least one fixed mark, and if possible two on every set of photos, so that all traverses could be co-ordinated on the maps.

The method of obtaining these was as follows:—On one side of the machine was the camera, so placed that the pilot could reach and work it. The observer was only engaged in watching the horizon for the enemy. The pilot having arrived at the correct altitude, considered the wind and set to work. He brought his machine into line with one end of his traverse going dead slow to deceive the anti-aircraft guns. He then put on speed in time to take one plate before he was directly over the beginning of the traverse, and started to fly along his line and expose the plates. The camera held 18 plates in a box on top. Under this was a sliding sheet of metal which he could push backwards and forwards and so remove the exposed plates to the box attached to receive them. The pushing over of the slide reset the shutter, and when the handle was drawn back a new plate fell into position. The pilot released the shutter and repeated the operation till the 18 plates were exposed. The exposures were so timed that the ends of consecutive plates overlapped. The lenses were of 4·5 aperture, and exposures of about 1/75 -1/100th sec.

As the altitude at which exposures are made increases, the plates cover a larger and larger area and the detail decreases.

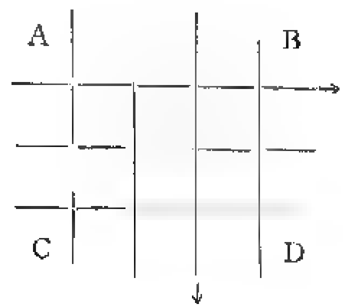
Hence the instructions to a pilot setting out usually told him how high to go. Further fewer plates would be required the greater the altitude and plates were taken at the highest altitude compatible with required accuracy of detail. The more that is represented on a single plate the smaller will be the scale of the photo, therefore altitude governs scale.

The speed of the machine will also determine how fast the exposures are to be made. The faster the camera travels over the ground the shorter will be the interval between the exposures. The machine's speed will depend on the machine's flying speed, *i.e.*, the normal speed at which it is designed to fly in dead-still air, and the velocity of the wind in which the machine is flying. The machine's speed is always known and the wind velocity can be calculated by the pilot whilst he is in the air He takes the time taken to fly a known distance on the ground near his working pitch and from that calculates the wind velocity. The number of exposures per min. at 7,000 feet in a machine travelling about 60 m.p.h. was about three or four. Thus it took about five or six minutes to run through a box of plates. Then the box had to be changed and a new one put on—no pleasant job on a cold day. Back the machine went and took up the traverse where it had left off. Several boxes were often taken in this way and great care had to be taken to get an overlap between the boxes. All this time ' Archie" was busy and as the pilot had to stick to one line and remain at the same altitude things were liable to get hot! Work had to stop and restart if " Archie" was too good, *i.e.*, the pilot broke off and side slipped, etc., till he could get back to the last point of exposure with a chance of being left in peace. One has much sympathy with driven birds.

To obviate all this a camera worked on the cinematograph principle was evolved, but was not found to be a complete success. Afterwards a mechanical method of changing plates was perfected and the observer had charge of it, whilst the pilot devoted himself to the machine and " Archie" dodging.

From the above it will be seen how a traverse line could be run, but sometimes it was necessary to cover a fairly extensive

area. This could usually be done by running one traverse alongside another and trying to obtain a lateral overlap. This is difficult and can be greatly assisted by taking a set of exposures cutting across the first lot, *i.e.*, AB to CD, AC to BD.



To help in this work special cameras were tried in each of which there was a series of lenses tilted around a horizontal one in the centre. The exposures from the centre one were used as controls, and the results from the others passed through a rectifying camera when the machine came down and brought to the same plane as the centre ones. In this way areas could be photographed as all the plates were arranged to overlap.

Eventually the plates were developed and printed. From these prints surveyors made drawings, which were used to fill in the maps.

Contours were a difficulty for some time, but it was found that by taking exposures that had been taken at some distance apart (*i.e.*, 300 yds.) and putting them in a stereoscope a strong depth effect was produced which was of great assistance. Shadow's varying with the time of day at which exposures were made were used to help in this work. The usual plate used was a 5 × 4 but exposures with larger ones were made for special purposes.

In peace-time flying it will be possible to obtain a photographic survey far more easily. There will be no enemy action. The first sets of photos over an unsurveyed piece of terrority will come in and the area will gradually be plastered with exposures. The detail will then be worked out as accurately as

possible, and any parts which are doubtful can be photographed from a lower altitude or a landing made for examination. Further, to help contouring photos will be taken of the country in panorama. There will be no machine guns or ammunition to carry and the spare room will be available for more plates and apparatus. As the work can be given out on a well-considered scheme and reasonable time allowed for repairs it will not be necessary to have such large staffs of mechanics, as was necessary when there had to be a large reserve of manual energy to meet an emergency.

A machine would fly at 60—80 m. p. h. for this work and carry two people to work it. It might take half an hour or so to get off and get the necessary altitude. It would stay up three hours working and then return. Say it is out four hours in all. In that time it might be expected to survey 3×60 miles of country $=$ 180 miles. The width of the traverse would depend on the altitude and type of camera used. Probably a four hour task in the air two or three days a week would be as much air work as could be expected from a pilot and his assistant. They might be expected to go up every other day, and on the alternate days their machine would be overhauled, whilst another machine carried on To tackle a tract of country at least two machines would be required, and a third would have to be in reserve in case of necessity. The staff to look after these machines could be divided into Hangar and repair staff. In the hangars would be men to meet and repair the machines on alighting and going away, to keep the hangars clean and execute minor repairs. For three machines two men should suffice. Then in the repair and overhaul section there would have to be several men, say about four for handling the engines, taking them to pieces and re-assembling them, work which would have to go on fairly continuously. It would be necessary to have a storekeeper and a clerk to attend to the office and keep all the machine log books. There would have to be a photographer to develop the plates, and a draughtsman to copy them. Responsibility for the whole would have to be concentrated in one man set in charge of the whole.

He would have to have a second-in-command to help him ; the latter might well be one of the pilots. Among the men, foremen or leading hands would have to be arranged. The staff would be—

1 Officer in charge.	2 Men in hangars.	1 Clerk.
2 Pilots.	4 Men repair work.	1 Draughtsman
2 Pilots' assistant.	1 Storekeeper.	1 Photographer
	15	

Average outturn 180 miles surveyed a day.

It is presumed that these surveys would be done in such places as the North-East frontier, where large areas are filled in at present by plane-tabling. In such places, in case of breakdown, there would have to be a large machine in reserve to go out with spares, food, etc., if required. In mountainous country it could be used to provision advance parties, which were not accessible by road. This would require a slight increase in personnel for looking after the engines, etc. A wireless outfit and operator would be wanted. The question of landing grounds for such a purpose naturally crops up. There would have to be a main ground large enough to take the large machine for a base alongside the railway line. There would be hangars of large capacity, and sufficient to take all the machines at one time. The advanced grounds would allow of the smaller machines landing, and the big one if possible. They would have arrangements to receive parachute deliveries from it.

It should be remembered that in a country such as the above that high forests and coppice appear very much the same, and special note would have to be made by flying low after the first survey in order to obtain necessary detail in doubtful places. This could certainly be done. The first surveys would easily show all main rivers and their tributaries and hills between them. On this skeleton would then be noted all the best looking timber

and landings made at intervals for a closer inspection. It is believed that in such places as the Abor hills, Bhutan, etc., and behind them again to the north a mass of valuable information could be gained.

Protection.

In Canada and the United States fire-protection is being assisted by flying machines. When a machine is in the air at about 2,000 ft. a large stretch of country is visible and fire and smoke are immediately seen. Patrols would have to go all day over the area to be protected The beats could be about 60 miles in length, whence a huge area could be watched. Directly the pilot saw any suspicious signs of smoke he would make toward the spot and investigate, send back a report on his telephone if necessary for help to be sent out

It is also likely that it may be found possible to destroy insect pests from the air by cruising up and down over the forest attacked and dropping or squirting disinfectants on to the canopy of the wood attacked; when heavy attacks of such things as Dasychira are on the sal it should be possible to do much to abate the pest.

Sooner or later the "sportsman" will come on the scene and want to machine-gun animals from the air. On this subject a cutting from the *London Observer* is enclosed. This kind of thing will have to be rigorously put down. Forest animals will doubtless be able to hide under trees; but a machine would frighten them greatly. Horses when stampeded and bombed can hear the bombs and the machine long before anything hits them. They flee in panic. One attack of this kind in the jungle and all its inhabitants will never forget the sound of engines in the air. They will have no more peace and infinite damage will have been done to them. A machine had a forced landing on a Yorkshire moor and all the grouse tried to fly away. Large numbers fell in an exhausted condition in the streets of a town in that district. For one attempt of the above nature a pilot's certificate should be cancelled.

It will probably be found that by means of air patrols such places as the Sundarbans and the Bramaputra can be very

effectually watched from the air and attempts at illicit extraction of timber by smuggling down the rivers frustrated. Seaplanes could go alongside any rafts seen and investigate them. It would become almost impossible for the wily timber thief to send off warning to his accomplices that the D. F. O. had set out to patrol, as, if a machine left, he would never know its destination. It would also be possible to carry out the most sudden and unexpected inspections.

Utilization

As regards utilization, aerial transport may be of great value. There are certain commodities such as eggs, fish, fruit, seeds, etc., which have to be carried quickly and kept cool lest they decay. It would be possible to transport young seedlings and seeds very quickly from place to place with the least amount of damage and loss. For instance seeds, transplants, cuttings, seedlings, etc., could be easily brought from Africa for trial in India at experimental stations.

Valuable commodities such as rosin and lac which are not very bulky could easily be extracted from the inner recesses of mountains such as the Himalaya. A great saving would be effected as no roads would be required.

General

Within a few years India will probably be covered with network of aerial routes. These will begin by being frontier patrols, postal routes and surveys for pilotage purposes on the great rivers. Whether passengers will ever travel largely is a very debatable point From the forest point of view it will be possible to run the survey in conjunction with each of the above and the patrols will work in with the other two items. In addition to all this it should be remembered that there will be great use made of the air for the purpose of the ordinary survey. There will eventually be landing grounds and aerodromes regularly placed all over the country and these will be the foci for all flying operations in their neighbourhood. It will perhaps be objected that it will be impossible to survey and extract from such places as Bhutan because they are too hilly to afford

landing grounds. This is hardly likely to be the case, though it was put forward at a meeting of the Royal Geographical Society in London recently. In Macedonia and other parts of the front the conditions could hardly have been worse for landing purposes on account of the hills There were tracts of country 30 miles in length where no convenient permanent landing ground could be found. Bombs were regularly taken over hills of 8,000 ft. to their targets. In one year the squadron lost only one machine through its being impossible to make a successful forced landing in the hills and the pilot was unhurt, though the machine was smashed. Again on several occasions spies were landed by day and night among the mountains and on the most inhospitable and inaccessible spurs. Night reconnaissances and bombing raids were continually carried out in which the machines had to rise over hills and descend into valleys. There can be no doubt that work will be found possible in the same way in the Himalaya foothills and to heights and places of use to us.

As regards machines it may be well to point out that two-seaters are now on sale in England at £500 each with 80 h.-p. motors and capable of doing about 60 m p.h. It has been announced in the papers this week that a machine to carry 100 passengers is in existence.

A. N. DAVID, I.F.S.

June 1919.

AËROPLANES V. BIG GAME.

THE NEW (AND WRONG) HUNTING.

SPORT AND RISK.

BY R. J. CUNNINGHAME.

There are some indications that one of the most notable achievements of modern science is contemplating an action which will prostitute itself in the eyes of true British sportsmen and which, if carried into execution, will deservedly stigmatise its

advocates and adherents as scientific butchers. I refer to the, at present, tentative suggestion that aeroplanes be employed to enable so-called big game hunters to secure the destruction of the limited numbers of the world's stock of big game. It is futile to say that there exist unlimited numbers of deer, such as caribou, or African plain-dwelling antelopes, or elephants, in vast numbers inhabiting hundreds of thousands of square miles of uninhabited and unprofitable country. Quite recent experience in South Africa shows that a few men possessing as means of destruction only horses and muzzle-loading muskets succeeded in irrevocably reducing a land teeming with animal life and big game and even in exterminating certain of the abundant species. There may also be cited the case of the American bison, who, though he roamed over many States in America not so many years ago, has been rendered virtually extinct by a few years' systematic persecution with the aid of horses, the repeating rifle, and a mere handful of men.

Now it seems probable that a further instrument of annihilation is to be employed in the shape of the flying machine. Let us first of all look for some motive for employing this highly scientific instrument as a means to encompass the destruction of the world's big game. All men, from the earliest indications of man's existence, have been hunters, but the primitive peoples hunted solely for the necessity of maintaining their existence and without presumably any notions of what is termed "sport." Then, as man became semi-civilized, he still went on hunting to provide for his sustenance, but in addition to the skill required of him he intentionally introduced greater risk into the procedure, which is the *fons et origo* of the term "sport."

THE ORIGIN OF SPORT.

As the world became gradually more highly civilized, peoples grew less migratory, the area of permanent domestication increased enormously, the necessity for securing game to maintain existence no longer applied, and the more restricted haunts of big game were then visited only casually, with the sole object of sport and

the enhanced desire to acquire more accurate knowledge of the natural history of the world's fauna. Recently, and to-day to a large extent, nearly all forms of animal life have had a market value placed upon them either when killed or alive, and this mercenary development has resulted in big game, especially being hunted primarily for profit and secondarily for sport. The more game that can be speedily killed under auspicious circumstances the greater the profit to those concerned, and no element of sport enters into the process, as it would imperil the schemes for the acquisition of cash.

It certainly seems fairly evident, then, that any employment of flying machines as an engine of destruction of big game can only be made with a view to the destruction of game in bulk for the making of money, and in direct and absolute contradiction to the factor of sport. Many an ardent flying man may say that he gets all the sport he wants out of the flying part of the business, and the shooting of the game is a secondary and exhilarating consideration. But let him ask himself to define the term sport from an Englishman's stand-point, and he will begin to have some misgivings over the fitness of his new schemes for the scientific slaughter of big game.

THE ELIMINATION OF RISK.

It is not intended to enter the large problem of the ethics of sport, but we must have some idea of what is intended to be meant when the term is employed. Generally speaking, the simple matter of taking chances would cover most people's ideas of what sport includes, but we are not concerned with generalities, but with a specialized form of taking chances. The definition of sport that is essential to those who wish to be classed as sportsmen in connection with the hunting of wild animals, and especially big game, is that the conditions of offence and defence respectively should be maintained as equally as possible between the two combatants. If this is impartially adhered to the element of chance is agreeably enhanced by the prevalence of risk to the extent in many cases of personal danger involving a possibility

of the destruction of the hunter by the hunted. This only occurs when conclusions are entered into with the more formidable species of big game, but on tne other hand the real sportsman must allow for a fair chance for the escape by fleetness of the weaker forms of game should he be lacking in sufficient skill to kill them.

Having now arrived at some understanding regarding the meaning attributed to the term "sport," let it be applied to the procedure of the pursuit and destruction of wild animals by means of a man in a flying machine, and I do not think I need occupy further space in order to render it so plain that he who flies may read. In the pursuit and destruction of any sort of big game by means of aeroplanes there cannot possibly be manufactured any argument to prove that the participants in such a practice are entitled to the term of big game sportsmen. There is no need to indicate any more appropriate appellation, as such will readily suggest themselves to all those who are in any way acquainted with the infinite attractions, remote chances, and uncertain risks which surround the life of the natural big game hunter. He takes his chances either knowing or not knowing his risks, and the narrower his margin of ultimate success the greater in proportion is his legitimate satisfaction if he bags his beast. The aeroplane was designed, and is now in process of being perfected, to fight the more or less unknown forces of the air, and for those who are engaged in this most dangerous of professions I have the most profound admiration. But do not let them endeavour to envisage two forms of most genuine sport by the attempt to so hybridize them as to produce a despicable result

AFFORESTATION OF THE RIDGE AT DELHI.

For the purpose of this article the Ridge (like Gaul) may be divided into three parts. The Northern portion from the Alipore Road to where the Ridge finally ends is not being afforested but appears to have recently been protected from grazing and is rapidly becoming covered with shrubs at present about knee high. The central portion is the Ridge of Mutiny

fame. This portion is fairly well covered with shrub and tree growth. The Southern portion near the site for the new capital is the part to be afforested. It consists of a low quartzite ridge the highest point of which is 167 feet above the average level of the new city or 853 feet above sea-level. The average rainfall at Delhi based on the 30 years ending 1910 is 26·5 inches. As Delhi is supposed to date from the 15th century B.C. and has undoubtedly been a city of considerable importance for many centuries it is not surprising that the tree growth on the hills in the neighbourhood has been completely destroyed except where specially protected near temples or mosques so that the Gazetteer of the District describes the hills as follows: "Their surface is generally bare supporting little or no vegetation save a stunted Kikar *(Acacia arabica)* or Kari *(Capparis aphylla)* or the small bush of the Ber *(Zizyphus nummularia)*. * * * A moderate pasture is obtained by flocks of sheep and goats herded by Gujar boys. Areas open to grazing appear in the cold weather to be bare of soil as well as of vegetation as the innumerable blocks of quartzite sticking up hide the ground between. A more unpromising site for afforestation it would be difficult to find.

The natural covering of the hills was undoubtedly a scrubby forest of *Anogeissus pendula* and *Acacia Senegal*. For a long time I thought that these species had been completely exterminated but a few specimens of the former are now springing up from roots which must long have been in the ground on the Southern Ridge and the latter occurs on the central ridge inside a temple enclosure The following is probably a nearly complete list of all the trees and shrubs formed on the Ridge excluding species planted in the last few years and one or two species such as *Millingtonia hortensis* which have been planted but show no sign of being able to maintain themselves permanently:

Cocculus villosus.

Mærua arenaria Fairly common.

Capparis aphylla—Common

" *sepiaria*— Do.

Cratæva religiosa.

Flacourtia Ramontchi—Fairly common.

Abutilon indicum—Scarce.

" *bidentatum*—Fairly common.

" *muticum*—Only found at one spot.

Hibiscus micranthus—Common.

Helicteres Isora—One specimen seen.

Grewia populifolia—Common.

Balanites Roxburghii Common in places

Ailanthus excelsa—Planted, rarely self-sown.

Azadirachta indica Planted and self-sown.

Gymnosporia montana.

Zizyphus nummularia Very common, usually dwarf.

Dodonæa viscosa—Planted and self-sown.

Indigofera pauciflora—Scarce.

" *tinctoria*—Very common.

" *trita*—Scarce.

Tephrosia purpurea—Common.

" *villosa* } Common Apparently forms of one
" *Hookeriana* } species differing only in the pods.

Alhagi camelorum—Found locally.

Butea frondosa—Common.

Dalbergia Sissoo—Planted or suckers from planted trees.

Cassia Fistula—Fairly common as small specimens.

" *occidentalis.*

Bauhinia racemosa—One specimen seen.

Tamarindus indica—Planted.

Albizzia Lebbek—Planted.

Acacia arabica.

" *leucophlœa*—Common.

" *Senegal*—Found at one spot only.

Mimosa hamata.

Anogeissus pendula—Scarce.

Lawsonia alba—Only two specimens seen.

Opuntia Dillenii—Naturalized

" *nigricans* Do.

Stephegyne parvifolia—Found at one spot.

Pulicaria crispa Fairly common.
Diospyros cordifolia.
Salvadora persica—Scarce
„ *oleoides.*
Carissa spinarum—Common
Wrightia tinctoria— Do.
Cryptostegia grandiflora—Naturalized
Calotropis procera.
Dæmia extensa -Common.
Pentatropis spiralis.
Dregea volubilis.
Pergularia pallida.
Leptadenia reticulata—Found at one spot
Cordia Rothii Common.
Ehretia lævis— Do.
Withania somnifera.
Lycium europæum—Common
Tecoma undulata—Scarce.
Adhatoda Vasica—Common.
Lantana indica—Fairly common.
Clerodendron phlomoides—Common.
Ocimum gratissimum— Do.
Aerua javanica.
Salsola fœtida.
Flueggea Leucopyrus.
Jatropha gossypifolia—Self-sown.
Ricinus communis
Phœnix sylvestris—Scarce.

I have a list of trees and shrubs found on the hills in Northern Jaipur State and it includes practically all the species given in the above list. On the other hand there are several plants found commonly in Rajputana which are not now found on the Ridge though they doubtless once occurred such as *Melhania futteyporensis*, *Grewia flavescens*, *Sterculia urens*, *Boswellia serrata*, *Rhus mysorensis*, *Acacia Catechu* and *Euphorbia Nivulia*.

Considering the prolonged cutting and grazing to which the Ridge must have been subjected it is surprising that so many plants have survived and at least two of the above plants which I have not found on the Ridge have been collected near Delhi by Royle, that is within the last 100 years, so that they possibly still exist.

The Southern portion of the Ridge was fenced and closed to grazing at the end of 1913. At the time it was fenced it was just as bare as the portion now outside the fence. Except for a stray kikar or karil there was probably nothing that had not been cut and browsed down to a few inches. The recovery by a few years of protection has been remarkable. In the cold weather of 1918-19 trees and shrubs had sprung up from roots left in the ground and in places form thickets it would be difficult to get through. The species thus re-establishing themselves are mainly those which produce root suckers freely, such as *Capparis*, *Cratæva*, *Flacourtia*, *Balanites*, *Carissa*, *Ehretia*, etc., as well as *Butea frondosa*, a plant which in the young stage usually dies back to the base for several years before throwing up a persistent stem. These roots which have persisted in the ground only needing protection to enable them to grow up into trees must have survived for years in the form of roots with a few browsed twigs. It seems incredible that they can have survived since the 15th century B.C. even allowing for occasional periods during which Delhi was deserted, one of which is said to have lasted for 792 years. Introduction of seeds by birds and jackals seems more probable, but it is difficult to see at present a source close enough to supply the seeds and Balanites with a seed two inches long would not be carried very far even by jackals. It is probable, however, that in the past, especially during periods of trouble, the country surrounding big cities was very different from what it is to-day. It was probably often unsafe to send a herd of cattle outside the city walls in charge of a Gujar boy. Such conditions would explain how it was that during the mutiny the attacking force advanced "concealed in the brushwood stretching up to within musket shot of the walls." If the ground just outside the city was sufficiently covered to afford protection to troops as recently as 1857 the destruction of forest growth on the

Ridge must be comparatively recent and all difficulty in accounting for the immediate response to protection disappears.

The Southern portion of the Ridge which is being afforested is 2,500 acres in area with an average width of about a mile. Near the highest point there is a series of filter tanks in which water pumped from the Jumna for the use of the new Capital is filtered. A separate tank for unfiltered water has been built and from this a pipe line runs along the ridge at as high a level as possible. From this pipe line lateral pipes are run at intervals of about 300 feet to the area under planting operations. Plants are planted at intervals of about 25 feet in prepared pits, several plants of two or three different species being put in each pit. They are watered by hand at frequent intervals to start with and subsequently at intervals of about one month.

As the area planted increases in size it is obvious that the amount of water given to each plant must be reduced and the time will soon come when some of the area first planted will have to be left to struggle on with the natural rainfall. It will be interesting to see what happens to the plants as soon as hand watering is given up and it is pretty safe to say that large numbers of them will die. For about a month last hot weather the water-supply failed and the results are marked. I visited the works in the cold weather of 1917-18 and again a year later. On my first visit I noticed that *Pongamia glabra* and *Lucæna glauca* had been largely planted, on my next visit I did not notice a single specimen of these two species but found *Prosopis juliflora* very conspicuous. Many of the plants being planted on a big scale such as *Pongamia*, *Lucæna*, *Dalbergia Sissoo*, *Bauhinia purpurea*, *Cedrela Toona*, *Putranjiva Roxburghii*, *Terminalia Arjuna* and *Thevetia neriifolia* are quite unsuited to the locality and will either die when watering is stopped or linger on in favourable places making poor growth. At the same time it is only fair to the Superintendent of the Works to say that many plants have only been planted because they happened to be available whereas more suitable plants were not. Also that seedlings of much more promising plants are now being grown for future planting.

A forest officer accustomed to deal with large areas would probably start a work of this nature by trying to re-establish the indigenous vegetation which once covered the Ridge. This is being done by nature owing to the protection from grazing but at the same time planting or sowing of such trees as *Cratæva religiosa*, *Bauhinia racemosa*, *Acacia Senegal*, *Anogeissus pendula*, *Stephegyne parvifolia*, etc, which are suited to the area and do not spread very rapidly of their own accord would greatly hasten the process. As watering is possible any of these species could probably be established in two years and could then be left to look after itself. If at the same time plants of *Agave* or cuttings of *Opuntia* were planted the water given to the tree seedlings could be shared by these succulents and in the event of the former failing the latter would cover the ground. *Agaves* and *Opuntias* planted in this way would eventually probably become a nuisance and have to be kept in check by clearing but meanwhile they would cover the ground and improve the growth of the trees and the cost of any subsequent clearing operations would be small compared with the total cost of the plantation.

The Ridge being close to a big city affords the opportunity of creating a semi-wild botanic garden which I hope will not be missed. It would be easy and interesting to have a good collection of succulent plants, *Agaves*, *Euphorbias*, *Cacti*, etc., such as at present exists nowhere in India. There are many trees from the dry zones of Africa, Australia and America already in cultivation in Botanic and Government Gardens in India and these would certainly do better on the Ridge than they do in Calcutta for example. In Lahore there are at least five different forms of *Prosopis juliflora* and the two which so far have been tried on the Ridge promise to do very well. In India too there are many plants not found near Delhi such as *Acacia modesta*, *Catechu Letronum*, *Dichrostachys cinerea*, *Boswellia serrata*, *Sterculia urens*, etc., which would probably grow very well.

The main reason why such plants have not been tried hitherto is the difficulty of obtaining seed. Any forest officer who can procure seeds of plants likely to do well on the Ridge will, if he

sends them to Delhi, help to make the collection more interesting and I am sure that the Superintendent, Arboricultural Works, Delhi, will be glad to receive the seeds and give them a trial.

R. N. PARKER, I F S

1st June 1919.

NOTE ON THE RESULTS OF EXPERIMENTS WITH INDIAN TIMBERS FOR WOOD PAVING BLOCKS.

The following is an abstract from the records of the Forest Economist's office regarding the experimental use of Indian woods for street paving in Rangoon, Calcutta, and Bombay.

Rangoon.—The first experimental wood pavement was laid down in Rangoon in August 1806 when untreated Teak and Pyinkado blocks of dimensions $6'' \times 3'' \times 6$ were laid down over an area of 6,000 sq. feet in Merchant Street and Strand Road. The cost of the blocks worked out at Rs. 50 per ton for Teak and Rs. 42 per ton for Pyinkado and the cost of laying the pavement amounted to Re. 0-14-0 per sq ft. or Rs 7-4 per sq. yard.

In April 1914 the Chief Engineer, Rangoon Municipality, reported adversely on this pavement stating that he did not propose to extend the paving work for the reason that though the pavement had lasted fairly well the great degree of expansion to which the pavement became liable during wet weather made it impossible to preserve a true and even surface of the roadway which was found to lift and blister after heavy rains. For these reasons most of the pavement was taken up in 1913 though a further portion lasted until 1916 when this too was removed. On the whole, it was considered that the teak blocks were superior to those of Pyinkado and it was also found that Padouk blocks lasted well, some which had been laid in Edward Street being found in good condition after 11 years. On account of the extreme variations of the climate which was thought to be the cause of the above mentioned defects of irregular expansion and blistering it was finally decided that wood pavements were unsuitable for

Rangoon and the question of further experiments was therefore dropped.*

Calcutta.—The experiments in Calcutta have been more extensive and date back to 1902 when an experimental area of Clive Ghat Street was paved with teak blocks of dimensions 9" × 3" × 6 and 6 × 3 × 4½", the last dimension being the depth, which is invariably cut parallel to the grain of the timber. The total cost of the pavement worked out at Rs. 18 per sq yard. In 1906 the Chief Engineer reported that this pavement was in excellent condition and likely to wear well for many years to come as it had been carefully laid with timber of uniform quality.

During subsequent years the question of extending wood pavement in Calcutta was raised on several occasions but was invariably quashed by the Chief Engineer on the grounds that the small experimental area in Clive Ghat Street could not be taken as a criterion for the future, the two chief disadvantages to wood pavement in such a climate as Calcutta, apart from the impracticability of using such an expensive timber as teak on a large scale, being the objectionable smell invariably given out by such wood pavements and the additional defects of the alternate contraction and expansion of the blocks during dry and wet weather. As regards comparative cost it was pointed out that stone sett pavements were cheaper and altogether more economical than wood pavements. The question was again raised in 1913 when it was proposed to try wood paving on a more extensive scale and estimates were accordingly called for. However the rates quoted in the tenders (*viz.*, Rs. 18 to Rs. 20 per sq. yard) were so high as to be considered prohibitive. It was at this time, April 1913, that the proposal was made by the Forest Economist to supply experimental blocks free of charge in Calcutta provided the Corporation agreed to conduct the experiments. This proposal was agreed to. The necessary qualities of a suitable paving timber were said to be

*Appended is the report of the Chief Engineer, Rangoon Municipality, with a comparative statement of cost and method of laying

durability, hardness and non-absorptive power with the additional proviso that if the timber did not contain a natural oil it must be creosoted or dipped in tar.

It was first proposed to use blocks of *Hardwickia binata*, *Terminalia tomentosa* and *Anogeissus latifolia* but the cost, working out somewhat too high, it was finally, in February 1914, agreed that the waste sleeper ends of sal which would not require creosoting should be utilized for the purpose. These blocks were to be obtained from the Balaghat Division, C. P., and the dimensions fixed by the Chief Engineer, Calcutta Corporation, were length 8" (plus or minus 1"), width 3" or 4", depth 4", the last dimension to be exact and parallel to the grain of the timber. An agreement was finally made to supply 50 tons of the cut blocks but the sample hand-cut blocks having been rejected on account of their not being sufficiently accurately cut an agreement was entered into with a Calcutta Saw Mill to cut the blocks from logs supplied from Balaghat.

Accordingly in April 1915, 39,000 blocks were supplied, it being found that 41 tons of blocks could be obtained from 98 tons of timber. However of the total number of blocks supplied, *viz.*, 39,000 it was found that more than half had to be rejected on account of defects of sapwood and the faulty cutting of the faces and eventually 18,600 blocks or 23·27 tons were laid down in Hastings Street over an area of 3,593 sq. feet side by side with creosoted *Douglas Fir* blocks. Inspection of the laying showed that the sal pavement compared very unfavourably with that of *Douglas Fir*, the latter being very accurately cut and there not being one bad block in 24,000 whereas with the sal on account of uneven cutting it was found impossible to keep straight courses or make close joints thus indicating the necessity of the accurate cutting of the blocks in proper block cutting machines

The cost of laying the blocks amounted to Rs. 2,051 with an addition of Rs. 117 for freight and cartage. On account of loss of timber on the Railway and the high degree of wastage in conversion it was, however, impossible to deduce the total cost of this pavement. Although the pavement was laid down in May

1915 during the following rains it swelled up and the expansion joints left at the sides had been used up in less than two months. During the rains of 1916 this defect was further aggravated and the pavement burst up in places and the blocks had to be taken out and relaid. No less than three sets of expansion joints were made and used up. This constant increase of expansion joints caused the separation of the individual blocks by shrinkage during the dry season. The condition of the pavement was otherwise good and there was little to choose between sal and the creosoted *Douglas Fir* pavement though it was noted that the latter was wearing in a more even manner, which fact corroborated European experience that soft-wood blocks wear more evenly than hard-wood blocks. On account of the above-mentioned defects it was decided that the wood paving could not be considered a success and was unsuitable for such a climate as Calcutta and the experiment was therefore abandoned.

Bombay.—The result of the experiments carried out in Bombay is the reverse of that of Rangoon and Calcutta experiments, for whereas it has been definitely decided that wood pavements are unsuited for Rangoon and Calcutta, the experiments in Bombay have been a success from the start with the result that the work of wood paving is being annually extended.

The experiments were initiated in 1914. It was decided that the blocks should be of Teak and Jamba (*Xylia xylocarpa*) from the North Kanara Division, the size of the blocks being 9″ × 3″ × 5″. The blocks were sawn in the Dandeli Mill, North Kanara Division, and some of the Jamba blocks were subsequently treated with creosote, the remainder being untreated. By April 1915, 20,000 teak, 10,000 creosoted and 10,000 untreated Jamba blocks were supplied to the Bombay Municipality. These were laid down in Frere Road over an area of 7,522 sq. feet in March 1916. The laying of the blocks was carried out most carefully, a covering of tar and sand being given to prevent excessive moisture from affecting the blocks. The inspection in the following year showed that the pavement was wearing well and in April 1917 the Chief Engineer called for quotations for a further consignment of

1,29,600 creosoted Jamba blocks. However, at the suggestion of the Forest Economist the blocks were cut green and were not treated with creosote. At the beginning of 1918 the pavement was reported in perfect condition and an order was placed for the further supply of 1,70,000 blocks of which number 8,600 Jamba and 4,500 teak blocks were supplied to the Municipality during 1918 19. A further order for 200 tons of Jamba blocks was placed in 1919. The rate at which these blocks have been delivered in Bombay works out at Rs. 88 per ton of 50 cubic feet. The pavement is in perfect condition and therefore it may be presumed that wood paving is a proved success as far as Bombay is concerned

C. E. Cox,
Forest Economist.

The following is a copy of a report from L. P. Marshall, Esq., M I.C.E., M.I.M.E., Chief Engineer, Rangoon Municipality supplied to the Forest Research Officer, Burma :—

With reference to your letter No. 296/1—P—8, dated the 30th May 1919, I have the honour to forward a copy of a report on wood pavements prepared by Mr. Sturrat in 1900. All these pavements were taken up in 1916 and replaced by Asphalte and Granite Setts. In 1908 a blind end of Edward Street in block C-3 was paved with Padouk blocks 6 × 6 × 3" and a comparative statement showing cost and method of laying is also attached for reference. This pavement is still in existence and in good condition. There is, however, no traffic on this portion which is used as a stand for hand carts

2. For small repair work, wherever the road showed a tendency to give way, "Gurjan" wood blocks from the Andamans have been tried; but no records have been kept. We have not tried "Anan"* wood, nor any other kind of wood except those mentioned in para. (1) for laying experimental stretches of roadway.

3. Teak blocks were considered by the Municipal Engineer at the time to be superior to Pyinkado blocks but he was not prepared

* (*Fagraea fragrans*) (see *Indian Forester*, Vol XXV, 1899, p 442.)

to express an opinion on the Padouk wood as it had only been down for six months I am however, forwarding a Padouk block recently taken out from Edward Street which has been there for 11 years. The wood appears to be still in excellent condition.

4. I do not consider wood pavements to be suitable for Rangoon on account of the extreme variation in its climate. The expansion of the blocks was most marked in the rains, causing the kerb lines to be forced out of position frequently.

WOOD PAVING.

Comparative Statement showing actual cost and other information regarding the wood pavements in certain streets in Rangoon

Where laid	When laid	Area laid.	Actual cost exclusive of kerb	Cost per s ft	Number of Blocks			Size of blocks	Number of blocks per 100 s ft	Remarks
					Teak.	Pynkado.	Padouk			
			Rs. a. p	Rs a. p.						
Edward Street, north side of Fraser Street, Block C-3.	April 1908	3,400	2,418 0 0	0 11 5	..	...	23,500	6" × 6" × 3"	691	(1) Blocks laid on 6" soorkee on 1" sand (2) Blocks were laid with $\frac{1}{8}$" to $\frac{1}{4}$" joint all round and 1" expansion joint on either side of the kerb line Joints were filled in with pitch and tar to within 1" of surface and afterwards floated over with cement grout, expansion joints at side were filled in with clay (3) No repairs needed.

WOOD PAVING.

Comparative Statement showing actual cost and other information regarding the wood pavements laid in certain streets in Rangoon

Where laid.	When laid.	Area laid.	Actual cost exclusive of kerb.	Cost per sq ft.	Cost per sq yd	No. of blocks used: Teak.	No. of blocks used: Pyinkado.	Size of blocks used	Number of blocks per 100 s. ft	Remarks
		S. ft	Rs. a. p.	Rs. a. p.	Rs. a. p.					
(a) Merchant Street between Sulé Pagoda Road and 32nd Street	August 1896.	6,000 = 666 s. yds.	5,150 11 7	0 14 0	7 14 0	17,794	24,056	6"×6 × 3	698	*Laid on cement concrete foundations. This pavement has been laid for 4 years and has stood well requiring little or no repair Small hollows are beginning to form on the surface, the blocks are very little worn and could easily be turned at little cost.
(b) Strand Road between Latter and 21st Streets.	July 1897	5,820=646 s. yds.	4,410 4 0	0 12 0	6 12 0	11,124	3,068 20,664	6"×6"×3" 8"×6"×3"	[illegible]00 536	Laid on lime concrete foundations. Has stood the heavy traffic wear during the past three years and has required very little repair.

*Paid in repairs, June 1901, Rs 93-1-3.

WOOD PAVING.

Comparative Statement showing actual cost and other information regarding the wood pavements laid in certain streets in Rangoon.

Where laid.	When laid	Area laid.	Actual cost exclusive of kerb.	Cost per sq. ft.	Cost per sq yd.	No. of blocks used: Teak.	No. of blocks used: Pyinkado.	Size of blocks used.	Number of blocks per 100 s. ft.	Remarks.
		S. ft.	Rs. a. p.	Rs. a. p.	Rs. a. p.					
c) Merchant Street between Sule Pagoda Road and 33rd Street.	July 1898.	18,048 = 2,005 s. yds.	14,186 5 5	0 12 7	7 1 3	85,371	14,229	8"×6 ×3"	552	Laid on lime concrete foundations. Has worn well, repairs were required to the kerb lines owing to being forced out of position by expansion.
(d) Merchant Street between 33rd and Barr Streets.	August 1899.	13,172 = 1,464 s. yds.	9,332 15 6	0 11 4	6 6 0	79,671	...	6"×6"×3" 7"×6"×3" 8"×6"×3"	719 612 557	Laid on lime concrete foundations, kerb lines were forced out of position by expansion of blocks, a sufficient expansion joint not having been left when the pavement was laid.

(e) Strand Road between 21st and 23rd Streets.	August 1900	26,175 − 2,908 s. yds.	26,559 10 11	1 0 3	9 2 4	92,000 37,840 48,600	... ...	6″×6″×3″ 7″×6″×3″ 8″×6″×3″	717 634 554	Laid on stone and cement concrete foundations.
NOTE.—Cost of Macadam 6″ thick on laterite bed.	...	...	...	0 7 0	4 0 0	...	...	...	...	
Cost of remetalling with 6″ metal.	...			0 5 0	2 13 0	...	...	...	...	
Cost of renewing and relaying wood blocks	...	...	...	0 8 0	4 8 0	...	...	...		

TOWN HALL:
26th September 1900

(Sd.) J. STIRRAT, M INST C E.,
Municipal Engineer.

ANNUAL RINGS IN SAL.

The ordinary irregular sal forest is regarded generally as of unknown age. It has not been demonstrated hitherto that the concentric rings in sal are trustworthy, that is to say, "annual." Or else it has been concluded that they are indistinguishable.

As matters stand, the problem of sal from the point of view of statistical research is a tough proposition It may take many years to obtain figures of rate of growth, for the various qualities of forest, from observation plot statistics. Now sal comes high in the list of important timber trees. We desire in many districts to convert "uneven-aged" crops to "even-aged" forest Statistics of rate of growth are therefore in demand.

My endeavour will be to show that sal rings are distinguishable at least in certain localities; and that the rings seem to be annual. My statistics are as yet meagre and insufficient to prove these contentions. The case is, however, to my mind, strong enough to justify the pursuit of investigations, both here, where the rings are distinguishable with certainty, and elsewhere in localities in which the rings have been considered hitherto to be indistinguishable

According to old inspection notes, it is evident that 35 years ago Mr. Gamble believed that the sal tree formed annual rings and that the rings could in certain circumstances be counted. In *Indian Timbers*, published in 1902, he gave a few figures regarding the rate of growth of sal; and it is evident that these were obtained by ring-counting.

At that period, however, sal was grown everywhere in uneven-aged crops. Statistics from observation plots showed that, as a whole, such woods grew at a rate far slower than that suggested by Mr. Gamble's figures. Presumably it was known that his figures were based upon ring counting; so the discrepancy was likely to have discredited sal rings. The reason is clear enough at the present day Mr. Gamble had examined only healthy trees of free growth In uneven-aged sal forest, it is only a tree here and a tree there that suffers no interference from its

neighbours throughout its life. Mr. Gamble's figures are applicable to tended even-aged forest alone. Had the sylvicultural needs of sal been understood there could have been, in the period of which I speak, no question of comparison between his figures and the "uneven-aged" forest figures.

In 1916 it was stated by an authority that sal ring-counting could not be depended upon. I have tried to assemble the causes for disbelief in sal rings.

As regards the old-fashioned calculations based on the general rate of growth of uneven-aged observation areas :—Such calculations have been known to show that in Selection forest of *sal* on the plains as long a rotation as 150 years is required to produce a 6′ tree. Those of the 150 year way of thinking, who have enumerated, probably with great difficulty, the rings on the stump of an ordinary mature healthy plains *sal* tree having arrived at about 70 years as the age, may have concluded that something was amiss with ring-counting.

Secondly, the "dying back" habit of *sal* seedlings under shade and the consequent uncertainty as to the time taken to establish a plant has been a difficulty. We have learnt lately, however, in the Ghumsur forests of Ganjam district, and elsewhere, that *sal* plants can be established in clear-felled areas* in one year, either by cutting back small advance growth or by broadcast sowing, and the above difficulty does not therefore arise. We are interested only in the age rate of growth of the tree from the time at which it ceased to "die back" and began to grow steadily.

A third objection is the tendency of *sal* to form false rings. I have experience of *sal* ring-counting only in the Ghumsur forests and have not found that false rings were a practical difficulty. There are false rings; but they are recognizable as such. When in doubt I have generally included doubtful rings in the count.

The fourth difficulty—*which is said to be insurmountable usually*—is that of distinguishing the rings.

* This does not refer to localities in which frost is experienced.

In the Ghumsur forests, for which working plans are under preparation, there are two small untended and generally paralytic observation plots, over which we may draw a veil. No other source of information being available for determining the rate of growth of the several qualities of *sal*, I was constrained as Working Plans Officer to try my luck with *sal* rings. It seems certain, here at any rate, that *sal* trees for rings which are "annual," and that the rings can be counted. In Ghumsur *sal* is truly deciduous; and for this reason perhaps forms fairly well-defined rings.

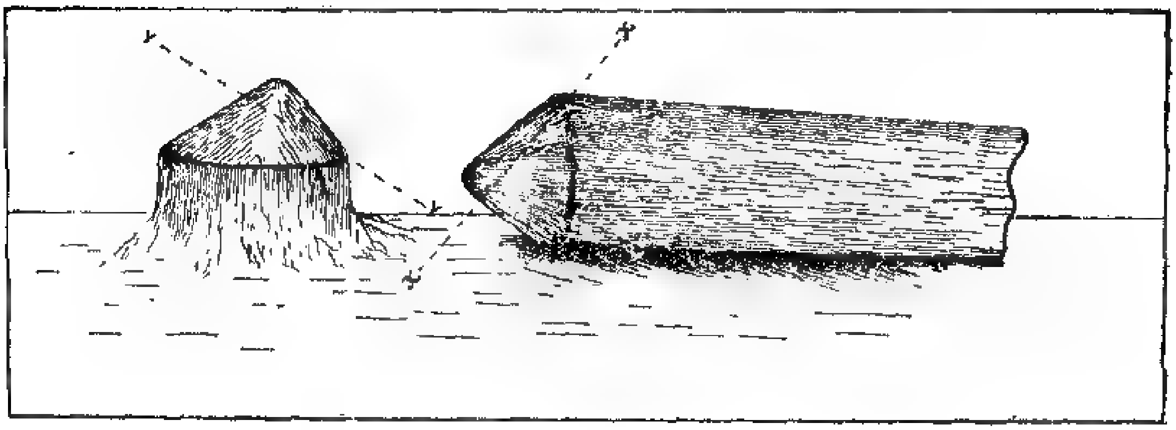
Ring-counting with *sal* is nearly always difficult. An account will be given of methods that were found to facilitate the process:—Results obtained by the use of the Swedish Increment borer, which appears to be the strongest and the best, cannot be trusted very far. The borer brings out only a core of sap-wood; and false rings in sap-wood are the hardest to distinguish. Something can be done by this method if the freshly removed core is given a clean surface with a razor; but the difficulty remains of detecting a false ring with only a minute arc of the circle to judge by.

In tabulating the results of ring-counting the forms recommended by Mr. R. S. Troup in his "Practical determination of the girth increment of trees" have been used, and the book was of great assistance.

Only sound healthy trees, whose growth throughout has been unretarded, are serviceable for purposes of ring-counting; and in calculating for the even-aged crops of the future there is no objection to applying results obtained from such trees.

Sal annual rings "are visible only in young trees or on freshly cut wood," according to Mr. Gamble's book; and this is correct. Before attempting to count the rings in mature trees it is advisable to obtain sections of a number of stems from coppice coupes of known ages, and to study the characteristics of the younger rings. On a horizontal section they are less distinct than on an oblique section. The method followed was to be present at the felling of the trees dealt with. In Ganjam felling by axe and saw

combined is not in vogue, so directly the tree has fallen it is necessary to have a plane surface prepared with the axe (x—x′ or preferably y—y′ in the diagram).



A steel American plane can then be used. Any delay in preparing the surface makes it harder to distinguish the rings. Sitting over the section one proceeds to emphasize with a pencil, along short arcs, the rings which are most easily recognized. Frequently a complete counting can be done only along an oblique radius which generally is not the "mean radius." Having marked all the obvious rings, one turns one's attention to the more obscure portions until the count can be completed from the central ring to the cambium. If it appears that the tree has gone through a period of marked suppression it may be rejected at once. Not only is the recognition of rings in a "suppression period" mere guess-work; but, even if the enumeration can be completed, the result will not help us towards our objective,—the rate of growth in a correctly grown even-aged crop.

Having completed the marking, a line is drawn across the marked rings from the centre of the first ring to the bark. Along this line, starting from the core, inch lengths are marked. The age at each inch is then recorded. It was found convenient also to write the results on the wood, as the pencil rings remain visible after the rings themselves have dried and have become

obscure. As we are satisfied that *sal* plants can be "established" in one year, it is unnecessary to make allowances, at the core of the tree, for a period of establishment.

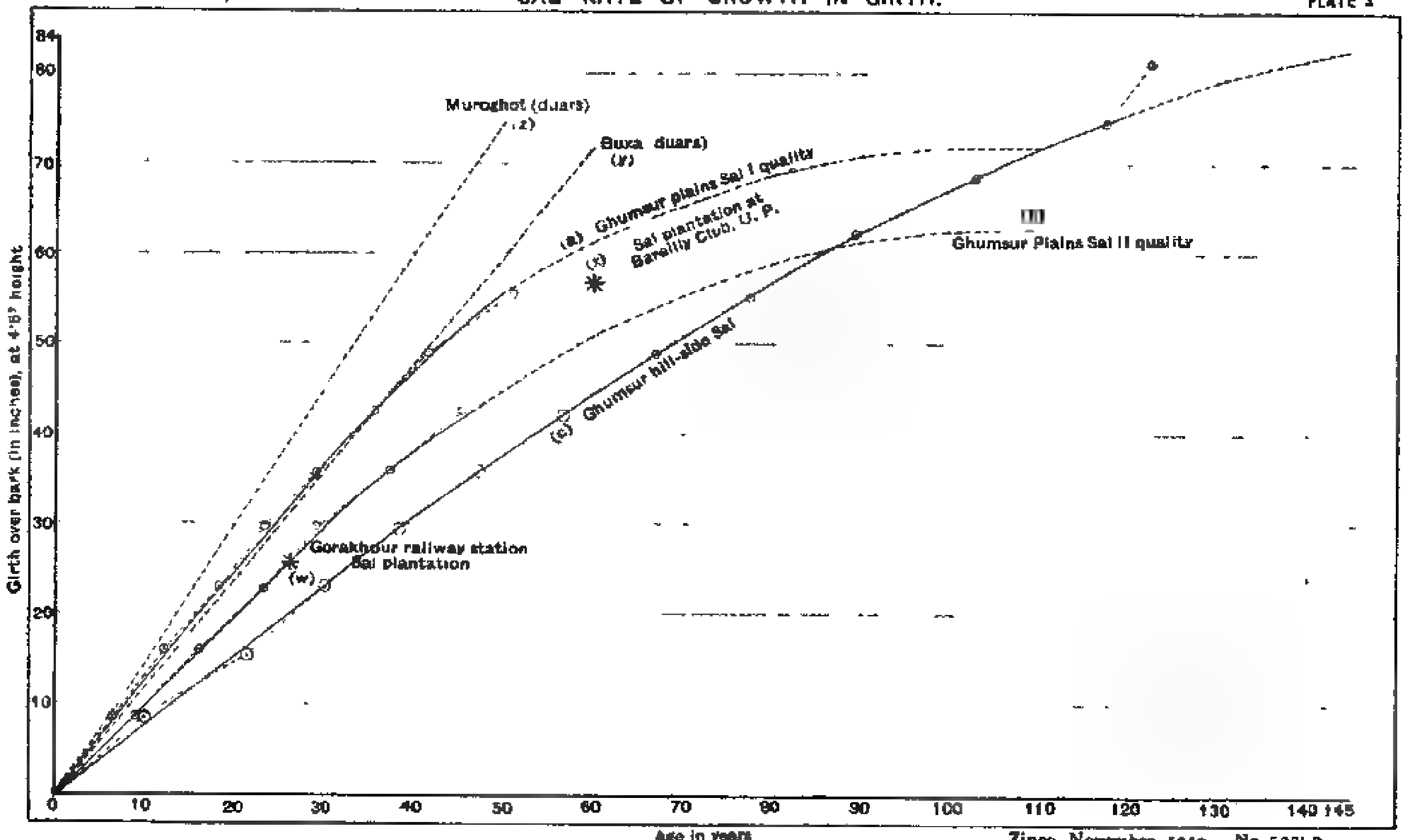
It will be observed that, so far, we have obtained the age of the tree at a point *close to the ground* (hence probably the whole age); but that the figures recorded apply not to the true mean radius of the stem, but to an oblique axis which may be considerably longer than the true mean radius. Also if the results are to be of any practical use we desire that the rate of growth arrived at should be expressed with reference to the girth of the tree at 4′ 6″ with bark on.

The girth of the tree at 4′ 6″ with and without bark is required and is available by direct measurement. But it is I think better to calculate the "without bark" measurement by using average figures from a graph of bark thicknesses based on numerous measurements. The results obtained are now to be reduced in proportion to the "mean radius," without bark, at 4′ 6″. (Mr. Troup describes in his book reducing scales which may be used for measurement of girth increment along *any convenient radius*. I experimented with the flat scale and obtained with it correct results. It made, however, for quicker field work to record measurements, as described, and to work out the "reduced" figures subsequently by geometry or by calculation.)

With *sal* in particular it would be difficult frequently to count the rings along a particular radius corresponding to the girth at 4′ 6″. The heart of a *sal* tree is usually eccentric. In accepting—as we must—measurements along "any radius" we assume that the laying on of increment on different sides of a tree (in which the core is eccentric) has continued throughout its life in the same proportion. If we take mean results from a number of normally shaped trees, as has been done in the present instance, the possible error in the above assumption will be insignificant.

From the statistics assembled we desire to produce graphically a mean curve. As a preliminary, curves of girth increment for all the trees of one quality are plotted together on to a single diagram, with a view to making abnormalities apparent. I found,

SAL—RATE OF GROWTH IN GIRTH.



Zinco November, 1919.—No. 5831-2

for example, that several of my trees had to be discarded as their curve of growth showed the characteristics of ordinary coppice. The average curve of growth is worked out from such data as are *accepted, and the final graph shows "girth over bark, at 4½' height" and the corresponding age. Figures of girth and age of *sal* in Ghumsur given by Mr. Gamble in an inspection note in 1884 agree with my own results. Mr. A. W. Lushington, C.I.E., who was then District Forest Officer in Ganjam, accompanied Mr. Gamble on this 1884 tour and assisted in the ring-counting. He tells me that the cells which determine the rings in *sal* are probably resin ducts; this is by analogy with certain Philippine island Dipterocarpus that have much in common with *sal*.

The accompanying graph (Plate 3) shows (*a*) the average rate of growth of Ghumsur Plains *sal* 1st quality, (*b*) ditto 2nd quality, and (*c*) "Hillside *sal*." Other lines and points are included as a matter of interest. The point "W" (which falls on the Ghumsur, 2nd quality, Plains Sal Curve,) is fixed by reference to data in Mr. Marriott's Gorakhpur Working Plain; and is intended to show the age and size of the average tree in the Gorakhpur Railway station *sal* plantation. Point "X" represents the actual average growth of the *sal* plantation in the Bareilly Club compound, at the age of 60 years. Lines Y and Z are drawn in accordance with figures given in "A Note on the Forests of the Duars" (1915), and show Mr. Troup's forecast of the rate of growth to be expected in plantation-growth *sal* in Bengal. The forecast for Buxa *sal* is based upon the growth of plantations 37 years old, and in the case of Muroghat on that of a 19-year old plantation.

The red dots connected with curves (*a*), (*b*) and (*c*) show the actual graphs of growth obtained from my ring-counting statistics.

* My statistics are included in the appendices to the Ghumsur Working Plan, which is under completion. If anyone wishes to see the figures on which the curves, now given, are based, I shall be happy to send copies. The curve for I quality Plains *sal* is based on data from 11 trees; 2nd quality from 8 trees, and "hillside *sal*" from only 5 trees. These trees were certainly fair representatives; but, of course, more figures are wanted2for each class. "Ravine *sal*," in high valleys, has not been examined yet, but appears to be somewhat similar in rate of growth to I quality Plains *sal*.

The course of the red-dotted line, commencing at about the year 120 in curve (*c*) requires comment. The line, at this point, depends on figures from two trees only; and for some reason (which I cannot furnish) these two had a sudden burst of fast growth in what should have been their declining years. The curves *adopted* are the black lines. These latter look fairly satisfactory; (*a*) and (*b*) cannot, however, be expressed accurately in any simple algebraical equational form; I am more hopeful of (*c*).

Finally I hope that ring-counting with *sal* will be tried elsewhere. It is very slow tiresome work; but it would be a pity if *sal* were to remain unnecessarily in the category "trees of unknown age."

A. F. MINCHIN, I.F.S.

9th June 1919.

VOLUME XLVI NUMBER 2

INDIAN FORESTER

FEBRUARY 1920.

THE FINANCIAL POSSIBILITIES OF EVEN-AGED CROPS IN BURMA.

Now that the formation of even-aged crops and especially of plantations is once more engaging our attention, it seems advisable to work out in some detail a forecast of the profits that are likely to accrue. This is all the more necessary as there are still some doubters of the uniform system and the previous published forecast made by Mr. P. J. Carter do not err on the side of optimism.

Since P. J. Carter published his tables, we have further data given in Mr. Leete's memorandum of Teak plantations and "The Nilambur Working Plan." Unfortunately full details are not yet available for the latter which must be full of interest for a Burma Forest Officer.

At present only the tables for the final and intermediate yields up to the age of 75 for five separate qualities have been obtained from the Working Plan, but these give us some very useful figures. In the following calculations for teak it has been assumed that the quality of soil is similar to No. II or medium quality at Nilambur and that by prolonging the rotation from 75 years to 120 years a

final yield equalling the maximum quality at 75 years at Nilambur is attained. This gives a final yield of 41 stems cubing 3,683 c.ft. Intermediate yields up to the age of 65 agree with those obtained in Nilambur II quality and subsequent intermediate yields have been taken to reduce the number of stems from 58 in the 65th year to 41 to equal the Nilambur figures for the maximum quality.

Costs.—1. Formation.—This is a most important point which I propose to deal with in some detail. The initial cost has always been assumed to be Rs. 12 per acre (*i.e.*, 1,200 plants 6′ × 6′ at Re. 1 per 100). This is the cost that has always been paid in the past and has generally been accepted. There is not the slightest reason why it should be accepted. In Tharrawaddy with the institution of Forest villages at first nothing was paid. The villagers were expected to weed all plants free and the actual planting was done departmentally. It was found, however, that this method offered no incentive to the villagers to secure a good percentage of survival and the actual cost of planting was Rs. 3 to Rs. 4 per acre. This year a payment of 8 annas per 100, *i.e.*, half the previous rates with a free supply of seed has been introduced. The cost will thus work out at Rs 6 for a full stocking and Rs. 2 which may be allowed for the cost of seed. In places in the N. Circle the planting is being done cheaper still. It is true that it is still necessary to pay the old rates to Karens and others who are not forest villagers and who have been accustomed to work for these rates but it is hoped before long that all taungya-cutters will be forest villagers who will work for the reduced rates.

Weeding.—The custom lately in Tharrawaddy has been to make two weedings each in the 2nd and 3rd year and one weeding in the 4th and 5th year. The weeding is done by contract at Re. 1-8-0 per acre. This has been allowed for in the calculations but at the same time it should be noted that the system of weeding has recently been materially altered and the result is likely to be a considerable decrease in cost. In the past it has been the custom ruthlessly to weed out everything but teak, and as a result a large number of quite useful tree species were cut out. Now weeding is done with a view to encouraging as much growth of tree

species as possible. Even in one year the result has been excellent and several plantations were found to be so fully stocked that a second weeding in the year after planting was avoided. The stocking may further be assisted by broadcast sowing of suitable species. Should this method be generally successful, there seems to be no reason why the cost of weeding should not be very materially reduced

Cleanings.—In this may be included thinnings up to the time the stems are large enough to be disposed of at a profit. A rough estimate of Rs. 2 per acre for cleanings in the 10th, 15th and 25th year is allowed. Mr. P. J. Carter's estimate of Rs. 10 for heavy unremunerative thinnings about the 30th year is not understood. In many of the plantations a thinning in the 25th year even may be remunerative and such heavy thinnings as Mr. Carter anticipated do not seem necessary.

General recurring expenses.—As in Mr. Carter's calculations 4 annas per acre per annum will be allowed for fire-protection, administration and other charges.

Early yields.—According to the Nilambur yield tables for II quality the average volume of the trees thinned out in the 25th year is 3·49 c.ft. Even this size in accessible areas in Tharrawaddy might be saleable at a profit. In the 35th year the average volume of thinnings is 7·05 c.ft. In Mr. Leete's memorandum on Teak plantations, Appendix V, it is seen that a tree of 35 years would have at breast height a girth of 3′ 7″. This might well be expected to yield a pole of at least 7 c.ft. Poles of this size would easily sell for Rs. 4 or Rs. 5 for houseposts and a clear profit of Re. 1 per tree may be confidently anticipated. In the calculations to be made therefore remunerative thinnings will start from the thinning in the 35th year.

Rate of interest.—P. J. Carter made his estimate for all rates of interest from 2 per cent. to 4 per cent. It is extremely difficult to say what rate of interest we should now employ. Mr. Carter seemed to think 3 per cent. to be the maximum interest that should be demanded by Government from its forest capital, and it is believed that this is the rate of interest employed in reckoning the profit on

irrigation, railways and other undertakings. It seems reasonable to ask Government to fix once and for all a rate of interest for forest valuation and I would suggest that 3 per cent. should be recommended. It may be held that a much higher rate of interest should be fixed owing to the present high rate of interest on Government paper. It is not likely, however, that this will be maintained and it does not seem fair to weigh down financial forecasts which may be realized after a great number of years by calculating with a temporarily high rate of interest. However to satisfy those who hold that a higher rate of interest should be used I have worked out calculations at 3 per cent. and 4½ per cent

Expenses					Present Value.	
					3 %	4½%
		Rs.	a.	p.	Rs.	Rs.
1. Cost of planting	...	6	0	0	6	6
2. Cost of seed	...	2	0	0	2	2
3 Weeding, 2nd year	...	3	0	0	2·9121	2·8707
4. " 3rd year	...	3	0	0	2·8278	2·7471
5 " 4th year	...	1	8	0	1·3726	1·3144
6. " 5th year	...	1	8	0	1·3327	1·2579
7. Cleaning, 10th year	...	2	0	0	1·4882	1·2878
8. " 15th year	...	2	0	0	1·2838	1·0334
9. " 25th year	...	2	0	0	·9552	·6654
Total A				...	20·1724	19·1767
Recurring expenditure 4 annas per mensem	...			...	8·0882	5·5273
Total costs				...	28·2606	24·7040
					Rs.	
Value of expenses at end of 120 years					981	4,861

Receipts.	Value at end of rotation @ 3 %	@ 4½ %
	Rs.	Rs.
Thinnings—		
1. At 35 years, 40 stems, 7 c.ft. each, @ Re. 1 = Rs. 40	494	1,686

Receipts.	Value at end of rotation @ 3%	@ 4½ %
	Rs	Rs.
Thinnings—		
2. At 45 years, 22 stems, 11 c.ft. each, @ Rs. 2 = Rs 44	404	1,194
3 At 55 years, 12 stems, 16½ c.ft. each, @ Rs. 5 = Rs. 60	410	1,049
4. At 65 years, 5 stems, 28 c.ft each, @ Rs. 10 = Rs. 50	254	563
5. At 75 years, 5 stems, 39 c ft. each, @ Rs. 15 = Rs. 75	284	543
6. At 85 years, 4 stems, 50 c.ft. each, @ Rs. 20 = Rs. 80	225	373
7. At 95 years, 4 stems, 60 c.ft. each, @ Rs. 30 = Rs. 120	251	361
8. At 105 years, 4 stems, 70 c.ft. each, @ Rs. 40 = Rs. 160	249	310
Final Yield—		
9. At 120 years, 41 stems, giving 3,683 c.ft., @ Rs. 50 per ton = Rs. 3,683	3,683	3,683
Total Receipts ...	6,254	9,762
Total Expenditure ...	981	4,861
Nett Return A ..	5,273	4,901
Ground value $\frac{A}{1.0p^{120}-1}$ = G ...	156	25
Ground rent G × op ...	4·68	1·125
If Rs. 12 is paid for planting instead of Rs 8 (items 1 and 2 in expenses) then ground value	152	21
And Ground rent ...	4·56	·945

The general purchase price of the best paddy land in Tharrawaddy District within fairly easy reach of the railway is about Rs. 100 per acre. At 3 per cent., therefore, the ground value compares favourably with this while even at 4½ per cent. the ground

value of Rs 25 is probably more than would be obtained for any other crop.

Moreover it is extremely probable that if a rotation of 120 years is retained, the final yield will be very greatly in excess of that estimated. The Nilambur teak of I quality attains a girth of 6′ in 70 years and the final yield at 75 years is then 46 stems yielding 3,260 c.ft. (In the above calculations the final yield of the maximum quality has been taken.) Much of our teak forest must be capable of yielding results as good as this and I have little hesitation in predicting that in the future we shall be content to grow our teak to a smaller girth and under a much shorter rotation. This being the case it is interesting to work out the ground rent for Nilambur I quality at a rotation of 75 years by which time it is estimated that the teak will be over 6′ girth.

Receipts.	Value at end of rotation @ 3 % Rs.	@ 4½ % Rs.
1. Thinning @ 25 years, 69 stems, 6·04 c.ft. each, @ 8 annas = Rs. 34 8 0	151	312
2. Thinning @ 35 years, 31 stems, 13·8 c.ft. each, @ Rs. 4 = Rs. 124 ..	404	721
3. Thinning @ 45 years, 17 stems, 19·9 c ft. each, @ Rs. 6 = Rs. 102 ...	248	382
4. Thinning @ 55 years, 11 stems, 25·6 c.ft each, @ Rs. 10 = Rs. 110 ...	199	265
5. Thinning @ 65 years, 5 stems, 44 c.ft. each, @ Rs. 16 = Rs. 80 ...	108	124
6. Final yield, 46 stems, 3,260 c.ft., @ Rs. 50 per ton	3,260	3,260
Total ...	4,370	5,064
Value of recurring expenses ...	68	145
Value of cost of formation at 75 years	185	521
Total expenses ...	253	666

Receipts		Value at end of rotation @ 3%	@ 4½ %
		Rs.	Rs.
Nett Return	... ...	4,117	4,398
Ground value	... ...	504	168
Ground rent	... ...	15·12	7·56

These results tend to show most emphatically that if teak at 6′ is sufficient for all ordinary purposes, Government will be incurring a very heavy financial loss in attempting to grow it much larger. Details of logs given in Mr. Hart's note on the Nilambur plantations show that for length and size a girth of 6′ can produce all that is necessary and the idea that extra girth is necessary if the most valuable lengths are to be obtained, seems to be definitely discredited.

Other species.—It is not only on teak that our future yields must depend and it is interesting at least to estimate the financial results for other species though, owing to our lack of knowledge of the rate of growth and even of the marketable value of many of these species our forecasts can at the best be very rough.

Pyingado (Xylia dolabriformis).—The rate of growth will probably be about the same as teak. For rough purposes we may take the cost of formation as in teak and the final and intermediate yields the same. The value may be given roughly as 1/5th the value of teak though this is undoubtedly much too low.

		3 %	4½ %
		Rs.	Rs.
Total receipts (as in teak ÷ 5)	...	1,251	1,952
Total expenditure as in teak	...	981	4,861
Nett return	...	270	2,909
Ground value	...	8	...
Ground rent	...	·24	...

It is apparent, therefore, that with this low valuation a rotation of 120 years will not pay. Working out, however, at the same

rate as Nilambur I quality with a rotation of 75 more favourable results are obtained.

		@ 3 %	@ 4½ %
		Rs	Rs.
Total Receipts	...	874	1,013
Less total expenditure	...	253	666
Nett receipts	...	621	347
Ground value	...	76	13
Ground rent	...	2·28	·585

This at any rate does not compare so very unfavourably with teak at 120 year's rotation and there can be little doubt that the prospects of pyingado are even more favourable than would appear from the above figures as the earlier yields which will give houseposts will fetch almost as good a price as teak. In fact pyingado houseposts are often preferred to teak, while Rs. 10 per ton must be considered a very low value indeed.

Yamane (*Gmelina arborea*).—Any forecast here must be pure conjecture : all we can say is that in favourable localities the growth for the first few years is extraordinarily fast. Trees in a plantation in Katha Division attained 38′ in height and 15′ in girth at breast height in three years. It may be assumed that it will attain a girth of 5′ in 40 years if properly thinned. Let it be assumed that at the age of 40 there are 60 trees of 5′, each tree cubing a ton value Rs. 5 per ton.

		@ 3 %	@ 4½ %
		Rs.	Rs.
Total receipts	...	300	300
Cost of formation as in teak, say Rs. 20. Value at 40 years	..	65	116
Annual recurring expenses 4 annas		19	27
Total expenses	...	84	143
Nett receipts	...	216	157
Ground value	...	95	33
Ground rent	...	2·85	1·49

This has not taken into account any intermediate yield which may be considerable, while the final yield is probably low and the value of the timber is likely to be far more than Rs. 5 per ton. The cost of formation is certainly less than teak owing to the rapid growth and little weeding necessary. Even then the profit is fair.

Conclusion.—To make further estimate would serve no useful purpose more especially as most of our timbers have not at present reached anything like their true commercial value. *Kanyin* probably *Dipterocarpus turbinatus* and *D. alatus* for instance are likely to be extremely fast growing and as they are capable of producing and seem to prefer a very close stand the yield per acre may be very large indeed. Sufficient has been written above to show that even-aged crops of teak and other species far from being of doubtful financial soundness may be capable even of holding their own with the best field crops and that too on soil quite unsuitable for permanent cultivation.

H. R. BLANFORD,
Deputy Conservator of Forests,
Tharrawaddy Division.

A POSSIBLE CAUSE OF "SPIKE" IN SANDAL.

1. The following are the considerations, which appear to me, to point to parasitism by sandal trees, as a possible cause of the disease known as "spike."

2. The symptoms of "spike," as far as they are known, are:—

(1) The diminished size of the leaves, their crowding together, and the continuity of growth.

(2) The congestion of starch in the parenchyma of the leaves and young shoots.

(3) The small proportion of salts in the leaves. (Noticed by Dr. Coleman.)

(4) The death of the root ends. (Noticed by Dr. Barber.)

3. The diminished size of the leaves, their crowding together and the continuity of growth, correspond, almost exactly, to the phenomenon known as "witches broom," which is caused by a parasite, and is due to the cutting off of the flow of sap. It appears on the branch of a tree, above the point attacked by the parasite. In the case of sandal, the parasite attacks the root; and if that attack is extensive, cuts off a large proportion of the sap from the whole tree. Both Dr. Barber and Dr. Coleman have expressed the opinion that sandal obtains the bulk of its crude sap by parasitism. If it does so, it must diminish the supply of sap in the host plant, by a corresponding amount. It may be asked, Why, if this is so, does not sandal kill other trees? We do not know that it does not do so; but its attack would be much more dangerous to sandal than to a normal tree, for sandal would be much more susceptible to such an attack, for the very reason that it is a root parasite itself, and, therefore, dependent for its supply of sap on comparatively few attachments to other roots, instead of on millions of root hairs, in direct contact with the soil. When the root of a normal tree is attacked by sandal, it probably puts out adventitious rootlets above the point of attachment, and the root hairs near the growing points of these new rootlets, immediately get into contact with the soil, and begin to re-establish the equilibrium, disturbed by the parasite. When a sandal root is attacked, it may, perhaps, put out adventitious rootlets also, above the point of attack; but every one of these rootlets has to find a host, and establish connection with it, before any benefit to the tree can result.

4. According to Mr. P. M. Lushington it has been found that spiked trees always bear numerous scars of sandal haustoria; but this has been found to be the case in healthy trees also. I doubt whether the latter part of this statement is literally correct; but apparently, for this reason, no further attention was paid to the fact that sandal does attack other sandal trees. In my opinion the fact is worthy of much more attention and investigation. In the first place, the damage done by these

haustoria must be a question of degree. A few haustoria might make little difference; whereas, a large number might cut off the whole supply of sap and thus kill the tree. In the second place, it is a question of position. If the bulk of the haustoria were below the points of attachment to the host, little damage would result If, on the other hand, they were above such points, they would cut off all supplies received from the host through the roots attacked. Suppose any other parasite had been discovered on the roots of sandal! Would its effects not have been thoroughly investigated, even though it were found on healthy as well as on diseased trees?

5. The congestion of starch in the leaves is the direct result of continued assimilation, the first visible product of which is starch, and of insufficient water to carry the starch off, and points to a diminution in the supply of sap.

6. The small proportion of salts in the leaves also points to a diminution in the supply of sap; for the salts are taken up by the roots in a very dilute solution, and remain in the leaves when the water is evaporated. It follows, therefore, that the quantity of salts, left in the leaves, will vary directly with the quantity of sap received and water evaporated.

7. The death of the root ends is probably due to the cutting off of supplies of food material returning to their growing points. It is true that the sandal haustoria are supposed to be chiefly engaged in extracting crude sap from the host; but to get at this sap, which moves upwards in the cell walls of the vascular bundles of the central cord, the haustoria have to pass through the cortical parenchyma, in which the food products are passing downwards. Is it not extremely probable that these products are also absorbed? As a matter of fact, I have corroborative evidence that this is the case; for, when searching for atttachments from root to root, I found one sandal haustorium attached to a seed. I did not think this of any importance at the time, and did not preserve, or identify, the seed; but it looked as if it might belong to an albizzia, and it had not germinated. Now the sandal cannot have been extracting crude sap from that seed;

because there would not be any If it was extracting anything at all, it must have been the food products stored up in the seed.

8. Returning now to the statement that:—"It has been found that spiked trees always bear numerous scars of sandal haustoria ; but this has been found to be the case in healthy trees also." The question is, whether the latter part of this statement is to be taken literally, *i.e.*, whether it means that the *scars* of haustoria are found on the roots of healthy trees ; or, whether it means, that haustoria are found on the roots of healthy trees. Personally, I have found only live haustoria on healthy roots and not very many of them, but I have not examined many. On the roots of diseased trees the haustoria would naturally die and drop off, because the roots are dead, and the fact that there are numerous marks of them is all in favour of my theory.

9. The evil, started by this habit of cannibalism, may not end with the death of the tree attacked. If the attacking tree is trusting wholly, or almost wholly, to the sap it obtains from other roots, *viz.*, the roots of another sandal, and the communicating sandal roots die, it is very probable that the attacking tree will also be affected by having its supply of sap cut off As stated above, the haustoria of the attacking root die, or, at all events, drop off. Unless, then, they are very soon able to make a fresh connection with a living tree, there would be every chance of the attacking tree getting "spiked" too. This would account for the spread of spike, in the immediate vicinity of the first trees attacked.

10. I must confess, at once, that I do not know how this theory can be reconciled with Dr. Coleman's grafting experiments. Mr. Hole has put forward an explanation as to how the disease might be communicated in that way when once established. That may be true, or the disease may be caused by some ultra-microscopic organism. I am not making any dogmatic assertion, that "spike" is caused by cannibalism, and that it cannot be caused in any other way. I am merely putting forward a case for investigation, for it seems to me, that while we are searching for ultra microscopic organisms, which may communicate "spike," under

artificial conditions, we are in danger of overlooking what Dr. Barber described in 1903 as "a greedy and constant parasite," which is plainly visible to the naked eye, and which may be capable of producing all the symptoms of "spike" as it occurs in the forest.

A. B. JACKSON, I.F.S.

UTILIZATION OF WHITE CEDAR (*DYSOXYLUM GLANDULOSUM* AND *D. MALABARICUM*) FOR OIL CASKS.

The following short note on the oil cask industry of Cochin is the result of a visit paid to the yards of Messrs. Aspinwall & Co., Cochin, through whose courtesy the writer was enabled to see the various stages of cask seasoning. The object of this note is to indicate the extreme importance and value of a good cask timber such as White Cedar and the great care taken in making and seasoning the casks. There is a very large business done in Cochin in shipping Cocoanut Oil to Europe for Margarine making and other purposes. The casks are made exclusively of White Cedar *(Dysoxylum glandulosum* and *D. malabaricum)* which is the only wood which has been found quite suitable for the purpose. The casks are made up by a number of coopers in Cochin who sell them to the exporting firms who take over the casks and 'season' them, this seasoning consisting in making them absolutely oil-tight. The casks which are mostly of a large size and hold a ton of oil are called 'Pipes' and are made by the coopers in the ordinary way; the dimensions are length 6 ft. and diameter of the top about 3 ft. There are 30 to 35 staves to the cask. The coopers have to supply the cask water-tight and when purchasing the firm sends a representative to test each cask and pass each stave to see that no timber other than White Cedar is used. The cost of the unseasoned cask before the war ranged from Rs. 25 to Rs. 30. Recently, however, prices have risen considerably and the maximum price reached was Rs. 180 per cask. The current price (May 1919) is Rs. 75 per cask. The process of seasoning costs about Rs. 20 over and above this figure so that at the present time a seasoned cask ready for filling with oil costs about Rs. 95.

The casks after purchase are taken to the firm's yards where they remain under cover for six months or more to allow shrinkage during which time the hoops become quite loose and the cask has to be remade. The heads are removed and the cask is refired and the bands tightened up by driving (Fig. I). The ends are then adzed and the groove is shaped with a specially shaped instrument to fit the heads, the groove being 1/4 inch deep. The groove is then measured with a compass and 1/6 of the circumference is taken as the radius of the heads. The heads or tops are then specially recut to allow for lateral shrinkage, *i.e.*, a top will be 33 inch diameter but 34 inch across allowing 3 per cent. for shrinkage across the grain. This is done by taking the top to pieces and fitting in another small stave in the middle. Each stave is then replaced and 'flagged' or packed with plantain fibre. Each stave is fitted to the next one with small bamboo dowels or pegs and there is also the 'flagging' of fibre between each which makes the whole oil-tight. The circumference of the top is marked out with a compass and cut (Fig II). The end of the casks for a distance of about 18 inches is then also flagged with fibre (Fig. III) and the tops are fitted on to the casks (Fig. IV), the bands of which are then finally again driven and it is then ready for testing. This is done by closing the bung of the cask and making another small hole in the side after pouring a quantity of water into the cask. The cask is then rolled to allow the water to get to all surfaces of the inside and a man then puts his mouth to the small hole and blows air into the cask. As he blows into the cask the tester stands by and marks with a piece of chalk any points where the water is seen to be oozing through (Fig. V). If the points of leakage are small they are plugged with bamoo pegs or reflagged but if serious a stave may have to be replaced. When the cask has been made to pass this test it passes to the final stage in which it is pumped with oil. The casks are put out in the yard and pumped full of oil (Fig. VI), the object being to make the staves soak up as much oil as possible and also to detect further leakage. If leaks are detected the oil is pumped into the next cask and the faulty one taken back for examination and repairs The casks

Fig I. Tightening the bands by driving.

Photo. Mechl. Dept., Thomason College, Roorkee.

Fig II. Marking and cutting the tops.

Fig III. Flagging the ends with fibre.

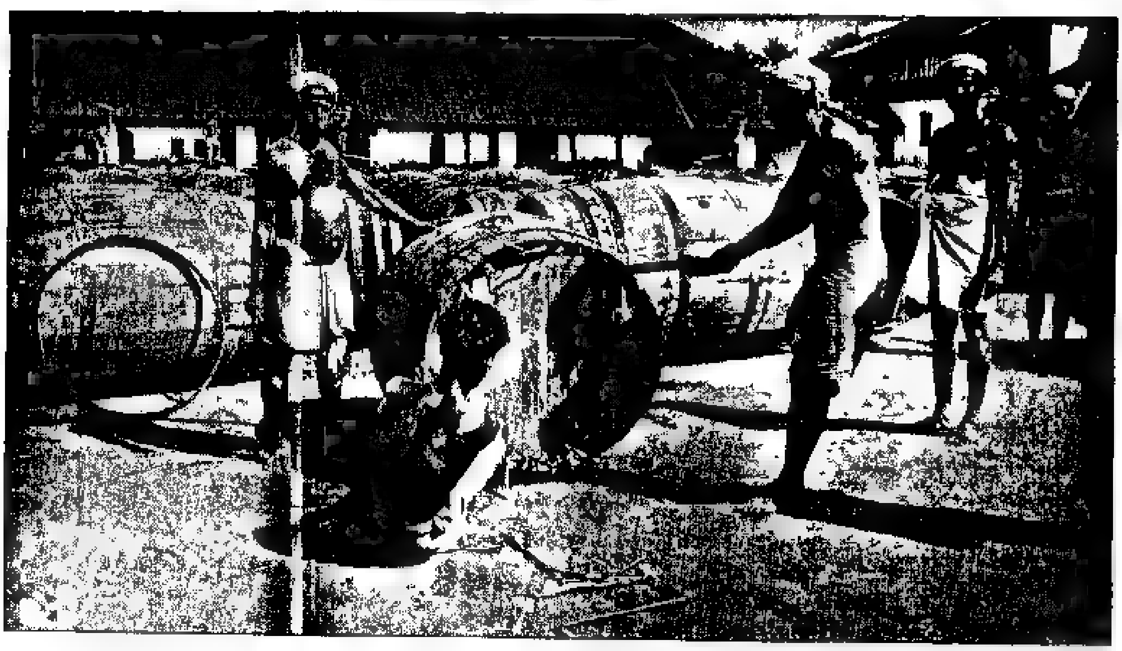


Photo.-Mechl. Dept., Thomason College, Roorkee.

Fig IV. Fitting the tops.

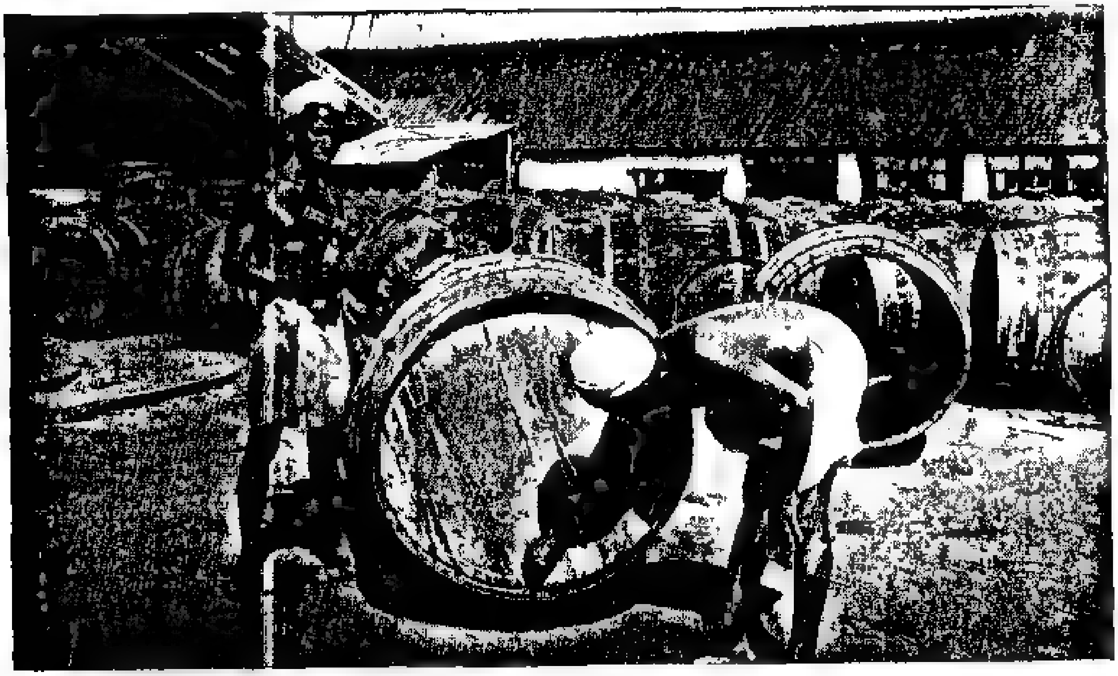


Fig V. Testing for leakage.

Photo.-Mechl. Dept., Thomason College, Roorkee.

Fig VI. Seasoning with oil.

are thus pumped with oil about 8 to 10 times until they will take up no more oil and are absolutely oil-tight. They are then passed into the godowns as seasoned casks and are filled with oil and shipped. The essentials of the timber used are that it shall not discolour the oil and shall not sweat, *i.e.*, allow the oil to percolate through the pores. With the exception of White Cedar no other timber has been found suitable for the manufacture of oil casks. At one time *Grewia* was used but proved defective, some opinions being that it sweated and others that it discoloured the oil. The general opinion of the cask-makers appears to be that White Cedar is the only really suitable timber for the purpose. This being the case we may expect that the attention of our sylvicultural experts may be directed to this species with a view to studying and extending its reproduction.

C. E. C. COX, I.F.S.

AERIAL PHOTOGRAPHY AND NATIONAL FOREST MAPPING.

BY ROLPH THELEN, OF THE FOREST PRODUCTS LABORATORY, MADISON, WIS., U.S.A.

[As the subject of Aerial Photography has been under discussion in this Journal the following article is reproduced from the Journal of Forestry for May 1919.—HON. ED.]

The development of aerial photography as a highly important and indispensable phase of modern warfare has been one of the many wonders of the great war. Photographic reconnaissance was practically unthought of during the early stages of conflict, and may be said to have been an outcome of trench warfare. At the time the United States entered the war this art had already become of tremendous importance, and in the final stages a complete detailed photographic map of each sector had to be made daily. General Squier states that the British Army made 17,000 photographs before the operations at St. Quentin in order that a relief map of the whole sector might be prepared before undertaking the drive.

Military maps of this character are commonly called mosaics, and are made as follows:—An airplane (other forms of aircraft could be used under certain conditions) equipped with a magazine camera flies over the area to be mapped, maintaining as uniform an altitude as possible, and exposures are taken at the proper intervals to insure a sufficient overlapping of the resulting negatives. If the area is too wide to be mapped in one flight, a number of parallel flights must be made, and the negatives of each succeeding flight must overlap those of the previous flight. After negatives have been developed, prints are made from them. If the accuracy of the map warrants it, the prints are all made to the same scale; this is done by making them in an enlarging camera instead of by contact. Distortion, caused by obliquity of the plate at the instant of exposure, can also be corrected in the enlarging camera if proper base points are available. The cameras are usually rigidly attached to the planes, and since it is impossible to fly continuously on an absolutely even keel, a certain amount of distortion is bound to occur. After the points are made, they are matched up, trimmed, and assembled into the finished mosaic. It is obvious that in the case of flat terrain it is possible by this means to produce an accurate scale map. However, in the case of mountainous country, this is not possible, since the scale will vary unevenly throughout the negative with variations in elevation. Thus a peak will be abnormally large in scale compared with a valley appearing in the same photograph, since it will be nearer the camera in elevation at the instant of exposure. The summit will be large scale, the valley small scale, and the slopes on various intervening scales.

In spite of this undesirable feature, this type of map answers Military requirements admirably, especially when accurate scale maps of the region are available, as was the case in France, and the main need for the photographic maps is to show the activities of the enemy. Points on the photographs can be tied in with the corresponding points on the scale maps, and the desired amount of detail filled in with almost any degree of accuracy. The speed with which aerial mosaics can be made is remarkable. The

Division of Military Aeronautics recently made a mosaic of the city of Washington and surrounding country in a total flying time of only 2½ hours. The area covered was 27 square miles.

The possibility of producing accurate topographic maps from photographs has been appreciated for many years, and the camera has been used for topographic surveys to a limited extent in India, France and Italy, and almost exclusively in the Dominion of Canada. Cameras used for this purpose are known as photo-theodolites, and are equipped with suitable cross-hairs levelling devices, horizontal scale, and magnetic compass, as well as with a small telescope for the reading of vertical angles.

In mapping an area suitable camera stations are selected and their exact geographic location determined by means of primary or secondary triangulations or by other suitable method of survey, and overlapping views of the area are then taken from each camera station. From the data obtained it is possible to construct on the drawing boards an accurate topographic map.

It would likewise be possible to construct topographic maps from aerial photographs, if certain necessary conditions were complied with. These conditions are, briefly, as follows:—

1 The camera plate must be truly horizontal when the exposure is made.

2. The optical centre of the negative must be determinate.

3. The overlap between successive negatives must be great enough so that the point on the ground lying in the optical axis of one negative appears in both the preceding and succeeding negatives.

4. The exact height of the camera above the ground at the instant of exposure must be determinate.

5. The whole survey must be tied in by base points of known geographical location.

Several makes of aerial camera have been developed for this class of work. They are arranged for flexible suspension in the airplane, and means are provided for keeping them vertical during flight. These means consist of gyroscopic control or suitably cushioned pendulum or plumb-bob action.

The trace of the optical axis of the lens on the plate may be readily determined by means of cross-hairs or similar intersection.

In order to secure the proper interval between exposures, so that condition 3 may be met, cameras are made either semi-automatic or fully automatic, and the provision made to time the interval between exposures to accord with the speed of the flight, the focal length of the lens, and other conditions.

In order that the exact height of the camera above the ground (condition 4) may be determined recourse will in general need to be had to some type of preliminary survey. There are several ways in which the desired object may be attained. Thus, if the relative height and the horizontal distance between two points appearing in two consecutive negatives be known, it is possible, by geometric projection, to locate the position of the camera relative to these points at the instants these negatives were taken, and similarly determine the relative heights and horizontal distances of all other points in the area covered by both negatives. Further, if the exact geographic positions of the base points be known, the geographic position of each point in the area can be determined. It is not necessary to know the geographic positions of the individual base points, however, since the whole survey can be based upon suitable benchmarks at the beginning and tied in with others at the end. The accuracy desired and other conditions will, of course, determine the exact method of procedure as regards control. In any event, it is evident that any kind of photographic surveying must be supplemented by a certain amount of terrestrial instrument work, and, as in all surveying, the more control introduced the better the map.

While the method just outlined is perfectly workable, its accuracy depends upon many more or less uncontrollable factors, and it has not been developed to a point where it is possible to say just what accuracy may be obtained. One is quite safe in saying, however, that great difficulty would be encountered in making a 50-foot or 100-foot contour map of rough country by any

methods so far developed. Some of the reasons for this statement are as follows :—

1. Even every slight divergence from the vertical in making an exposure would make a reasonably large error in the finished map. A 30-minute error from a height of a mile would displace the entire picture 45 feet and cause distortion on the entire plate.

2. Any shrinkage in the film or any lack of flatness at the time of exposure will produce highly magnified errors in the finished map.

3. Any errors in the lens will be magnified in the map.

4. The scale of the negative is relatively small, and the determination of the location of the points by the method of intersections is inaccurate on this account and on account of the acute angles of the intersecting lines.

5. Errors are liable to creep in as a result of inaccurate determination of the same point on different negatives, owing to change of its aspect from the different angles of view.

It is probable that scale maps could be drafted from aerial photographs with reasonable speed.

One manufacturer states that in experiments conducted by him it has been possible for one draftsman to map ten square miles per day with 700-foot contours. He believes that, with improved transposing instruments, 25 square miles per day could be mapped.

It is probable that the sketching of contours and the determination of various topographic features could be assisted materially by the use of stereoscopic views and a stereo-comparator, an instrument used to determine relative depths in stereoscopic views. Oblique views, properly chosen, would also be of assistance in determining topography.

National Forest maps are made and used for many purposes, and their character varies with the use to which they are put, ranging from the crudest sketch to contour maps of high accuracy. In many cases these maps are compiled from all the best surveys available, and recourse is had, not only to Forest Service data, but also to maps and surveys of the General Land Office, the

U. S. Geological Survey, the U. S. Coast and Geodetic Survey, and infrequently to the work of corporations or local surveyors. On some National Forests the amount and grade of existing surveys are much below the needs. Where the desired surveys and maps do not exist, it becomes necessary for the Forest Service to make the proper survey. This is especially the case when topographic maps are needed in the appraisal of timber and forage.

For the purpose of this article, Forest Service surveys may be classed as follows, the principal uses to which each is being put being shown as sub-heads :—

(1) Cadastral Surveys :
- Boundaries and acquisition.
- Entry Surveys.
- Administrative mapping.

(2) Topographic Surveys :
- Timber reconnaissance.
- Grazing reconnaissance.
- Soil reconnaissance.

(3) Engineering Surveys :
- Road construction.

At present we have cadastral maps of all National Forests, mainly compiled from General Land Office surveys, and though their accuracy and the amount of detail shown sometimes are not all that they should be, yet in general these maps are sufficient for ordinary purposes.

Topographic maps of perhaps one-half of the National Forest lands already exist, mostly on rather small scale for administrative purposes. These maps are utilized as far as possible as the basis for extensive timber reconnaissance, grazing reconnaissance, engineering plans and estimates, and many other important National Forest activities. But the more intensive timber reconnaissance, and certain other projects as well, demand topographic maps of fairly large scale and showing much detail. If not available, they must be made before the project is finished. For engineering construction, particularly, the control also must be reliable or wasteful expenditures might easily result.

In the standard Forest Service method of making an intensive timber reconnaissance two things are necessary: (1) to determine the exact stand and yield on certain sample strips, and (2) to estimate the character of the forest cover on the entire area. From this an accurate estimate of the stand and yield on the entire area is obtained. In practice, the party goes through with compass and chain, running parallel strips 1 1/2 miles apart throughout the entire area and measuring or estimating all trees in each strip. In case no good topographic survey of the area is in existence, a modified Abney level is used to determine the relative elevations every two chains along the strips as well as prominent topographic features between the strips. All these data are tied in with points of known geographic location and elevation and the result is a topographic map on whatever scale is desired, the accuracy of which can be made much greater than that of maps ordinarily made with plane-table and alidade, because of the vastly greater number of points to which the control is carried. Thus the necessary, though secondary, feature of the topographic base map is obtained practically as a by-product of the labour of the timber estimators.

Extensive timber reconnaissance and grazing reconnaissance are usually made by other methods, which do not lend themselves as readily as the strip method to the systematic gathering of topographic data. Either the base map used is the General Land Office survey, or extensions of it, or else a topographic base is made with plane-table and alidade. The contour, as well as the boundaries of the areas under forage, are determined, and the amount of forage on the area determined by inspection of suitable units, such as sections or drainage basins.

Having briefly outlined the manner of making aerial photographs and maps, sketched the requirements of National Forest surveys and reconnaissance and present methods of meeting the principal of these requirements, we may proceed to discuss the possible value of aerial photography as an adjunct or supplement to these methods.

Neither cadastral nor engineering surveys can be made by photography. They demand the setting of monuments and also a

degree of precision which cannot be obtained by photographic methods, especially in regions of bold relief. Hence photography can never do away with this kind of work, but each may supplement the other in the making of a fine Forest map. Every corner set is an additional control point. Cadastral plats are weak in detail, which is difficult to secure by present methods. An aerial mosaic of the area could readily be tied in with the monuments, and would furnish any desired amount of detail which could be drawn in on the properly controlled base. Thus every road or trail, creek, river, fence, or building could be accurately located with the minimum of effort and expense in the field.

In intensive timber reconnaissance, it is obvious that aerial photography as now developed cannot replace present methods, since neither the species nor the dimensions of the timber could be determined. Further aerial photography has not been developed to the point where it is possible to make topographic maps with a degree of accuracy approaching that secured by the standard Forest Service method employed in conjunction with intensive timber reconnaissance. An added difficulty is encountered in forested areas, in that the aerial photograph shows only the tops of the trees and not the ground underneath. However, an aerial mosaic would be a valuable supplement to an intensive reconnaissance in several ways. Possibly it would be of greatest assistance in furnishing an excellent check on the percentage of forested area and parks. The accuracy of the reconnaissance depends, of course, upon the accuracy with which this percentage is determined. In areas which are completely forested, the value of the mosaic for this purpose becomes very small. In any event, a mosaic would be of general assistance in working up the data into map form and would present a picture of the area in much greater detail than the standard topographic maps.

The usefulness of the aerial maps in connection with grazing reconnaissance is more apparent than in the case of intensive timber reconnaissance. While ordinarily topographic maps form the basis of grazing reconnaissance, it frequently happens that

such maps are not available, and it becomes necessary to make surveys before the reconnaissance can proceed. It is probable that in many cases of this sort aerial mosaics could be used as base maps. They would have the added advantage of showing clearly the limits of grazing areas, making much easier the work of estimating the forage. This advantage is present even where there are topographic maps available, and might be great enough to warrant making aerial mosaics in connection with all grazing reconnaissance.

Likewise in the case of extensive timber estimating, especially where suitable maps are not available, the aerial mosaics should be of great help. It would be accurate enough for all purposes and would show the boundaries of all timber areas. Further if stereoscopic pictures were made, a man familiar with the region could undoubtedly gain a very good idea of the actual stand from the photographs alone.

Finally, there are many areas in the heart of the National Forests on which no surveys or reconnaissances have been made, and, if the present methods are to be followed, it is probable that a large part of these areas cannot be mapped for many years to come. Mosaics of the lake and glacier regions might be of considerable value in the service work or promoting recreation uses of the Forests.

Aside from the several forms of reconnaissances, aerial mosaics or maps of the National Forests would be of assistance in various phases of forest administration. Thus the supervisor would undoubtedly find many uses for a map of this character in planning trails and roads, drift fences, and other grazing improvements and in aiding tourists and others in finding their way about. In fire-fighting, large scale maps of the region in which the fire occurs should be of real help, especially supplemented by aerial maps of the fire itself.

If aerial maps were made recurrently, they would afford the best possible permanent record of changes and improvements on the Forests.

In timber-sale work aerial photographs, whether in the form of maps or simply as oblique pictures, would add very materially to the value of the timber sale prospectus, since they could be made to show with great clearness and remarkable detail the entire area under consideration.

While aerial mapping is as yet a practically undeveloped art, especially in its application to peace-time requirements, the writer feels that sufficient progress has already been made, and its possibilities as an aid to forest mapping and administration are sufficiently evident to warrant careful study and thorough experimental investigation, possibly in connection with the training of military aviators.

RESPECTIVE MERITS OF TRANSPLANTING OR DIRECT SOWING OF TEAK IN PURI (ORISSA).

I enclose a report by Forest Ranger Babu Rabindra Nath Mojumdar on the respective merits of Teak sowings and planting in Puri district. It is too early, however, as yet to judge of the results. The sowings made ten years ago consisted of dibbling in Teak seed at stake without any ground preparation. This year thullies were made by digging holes, filling with humus and piling the excavated earth on the top so as to make a slight mound. Previous to 1919 seedlings were put out on mounds in clear-felled areas as it was found by experience that seedlings were less damaged by bison which tread the young plants into the ground. On each of the thullies so made three seeds were sown in June 1919. Sowings were late as the consignment of seed was late in coming to hand. A large nursery was also made in order to supply plants should the sowings fail.

In 1917 and 1918 plants were put out on cleared land at 6′ × 6′. In 1918 they were put out in lines 30 feet apart cut through evergreen forest. The change in the method of planting was made in order to get the largest possible area covered in the least possible time with the limited labour available. In 1918 for instance the area planted was only 15½ acres as compared with 73 acres in 1919.

Teak was planted in lines in the forest in 1908-09 and the results are excellent. The mixed forest on both sides has kept the teak growing straight and prevented the formation of double leaders or epicormic branches. These trees should give a clear bole of 40 feet when full grown. The evergreen forests keep the ground heavily shaded so that not a ray of sunshine reaches the ground.

Another advantage of planting in lines is that bison and deer do not give the same trouble as in cleared areas where they congregate to graze on the young grass and bamboo shoots till the ground in the rains looks like a farm yard. The work of preparing the lines was started very late in the season and as it was experimental it was done more expensively than necessary. This year an early start will be made so that by the hot season the cut stuff will be dry enough to burn. This will save the necessity of cutting paths through the thorny undergrowth The area is particularly suitable for Teak, the moisture laden air from the Chilka lake causing heavy drip from the branches throughout the whole cold weather. It is almost impossible to get the forest to burn, frost is unknown and up to the present defoliators have not appeared possibly owing to the fact that the Teak is exotic.

SUB-EDITOR.

COPY OF REPORT.

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If we review the previous Teak operations in this Range we find that all the old Teak cultures near Ankula and Baldiabhiri (done between 1898—1901) were sowings. The results were good, seedlings were healthy and made good progress, except where they were smothered under grass. Transplantings were done from 1905 to 1909 and again from 1915 to 1918; sowings were done in 1910—1914. The plantings of 1916 and sowings of 1913-14 were not successful, but the other sowings, like the transplants, grew quite well; and if the sowings failed here and there, we also find long gaps in the transplanted line. So as far as can be judged from previous work, sowing can well hold its ground against transplanting.

In this year (1919) we did our sowings a little late and to insure against any failure we had nurseries as well. We finished our sowings in June 1919 and began to put out transplants in August, allowing only little over a month for the germination of Teak seeds, but even then we had not to replace more than 30 per cent. If we could have afforded to wait a little longer the number of transplants would have been less as seeds continued to germinate Seeds sown in the Champagarh nursery did not germinate well at first, but when last seen (18th October 1919) the nursery was full of small seedlings. In comparing the germination and transplanting work of the year's operations we find the transplants to be bigger, on an average, than the germination; but it must be remembered that the transplants have been carefully reared in the nursery where they had a better start. On the other hand, we find very few deaths in the plants directly sown whereas many of the transplants died and had to be replaced.

The only advantage in transplanting is the certainty of raising the seedlings in the nursery, but the subsequent transport and planting of seedlings in the forest are very delicate operations and much depends on how these are done. As we are bound to depend on coolies for this work, however careful the officer in charge may be, he cannot supervise every cooly's work and a badly planted transplant is sure either to die or grow into a defective tree. Direct sowing minimizes the risk of death during transport and plantings but its drawback is the uncertainty of germination of seeds. But in Teak we have seen that given good seed it is sure to germinate sooner or later. So as far as Teak is here concerned direct sowing is preferable.

Now as regards cost jungle clearing, making pits or mounds, etc., direct sowing is decidedly cheaper as this does away with the cost of transport, transplanting and nursery.

A couple of coolies will easily sow 500 maunds a day, but to plant this number of maunds including carrying plants from nursery, ten coolies will be needed.

If we compare the systems of sowing used in 1919 of transplanting in 1917 and 1918, at first sight it will be seen that this

year's work is far more costly. In 1917 about 25,000 plants were put out at a cost of Rs. 950 and in 1918 about 20,000 plants were put out at Rs. 750 or an average of 26 plants per rupee, but in 1919 the average of all the plantations is only five plants to a rupee. In 1917 and 1918 there were about 650 plants to an acre and in 1919 there are 130 plants to an acre, so that in putting out 650 plants only one acre of jungle was cleared whereas for the same number of plants we had to clear five acres of jungle and the 2 feet trace has given a decided advantage. Thus in 1919 though the cost per plant is greater the cost per acre dealt with is nearly the same as in previous years, namely, Rs. 26 an acre. In the 1919 system we can see each and every plant at any time of the year and can attend to an individual plant, an advantage we did not have in previous operations. And previously the success was at best 80 per cent. but in this year's work hardly 2 per cent. are dead, and as replacing immediately followed we can depend on cent. per cent. success. This year we had to make a big nursery which was not wanted, a far smaller one would have been sufficient. With a small nursery and early clearing of jungle and burning the refuse we can bring the cost per acre a little lower. The cost of Nilambur plantations is about Rs. 50 an acre, all included; if we add cost of weedings and drip cuttings which has not exceeded Rs. 5 per acre and adding another Rs. 5 for subsequent tending, our cost will not exceed Rs. 36 per acre.

It will be seen from above that the system of direct sowing on mounds made on the side of a 2 feet trace and with a small nursery has the following advantages over transplanting from nursery as was done previously:—

(1) It is cheaper.

(2) It minimizes the risk incidental to transport and transplanting.

(3) It is easily managed

(4) It facilitates inspection.

(5) It gives a surer result.

THE PROFITS FROM ELEPHANT-HUNTING OPERATIONS IN UPPER ASSAM.

The capture of wild elephants in Upper Assam is carried on by lessees and not by Government agency. There are about half a dozen elephant Mahals in the Lakhimpur Division. They are put up to auction and a license is issued by the Deputy Commissioner to the purchasers, in respect of each Mahal, in the form prescribed by the Local Administration. This form contains all the conditions that govern the operations. Mahals are not leased annually, but are worked for two consecutive years which period is followed by eight years' rest so that a successful breeding stock may be ensured.

Mahal No. 1 comprised all the reserved forests in the writer's range and through them run well-defined tracks leading from the hills to the grassy banks and forests where the elephants go to graze and drink. Two very successful Kheddas, named the Bogrigarh and the Ghagargarh, were erected by the lessees on two of the bigger paths.

In 1917-18, eight elephants were captured in the Bogrigarh stockade, and in 1918-19, fourteen elephants in the Ghagargarh and eighteen in the Bogrigarh, including one which was caught in 1917-18 and again got loose after about five months' training. The total number of captures in these two Kheddas during the last two years was 40. Among these only one animal died in the Bogrigarh last year, as it was badly wounded by a tusker. To the misfortune of the purchasers one animal died of anthrax two days after it had been purchased and three more died of sunstroke within a fortnight of their sale. These casualties happened to those which were captured in the last week of March 1919 and probably resulted from the severity of the hot weather. All the newly captured elephants were disposed of within 25 days of their being caught, so practically no measures were undertaken by the lessees to train them. Purchasers had to train their own animals

The financial assets of the enterprise may be roughly shown in the following lines :—

The purchase-money of the lease was Rs 4,000. The Bogrigarh stockade was erected at a cost of about Rs. 700 in 1917-18 and again repaired at a cost of about Rs. 500 in 1918-19. The cost of running this Khedda for two years was about Rs. 5,000 and that of running the Ghagargarh was about Rs 3,000; several other Kheddas were erected at about Rs. 3,000 but not operated. Royalty on elephants at Rs. 100 each, irrespective of sex or size, came to Rs. 4,000, the total expenditure thus amounting to Rs. 19,000. The receipts from 38 elephants sold were about Rs. 42,000 and Rs. 250 was recovered on account of the capture of the runaway elephant. The total gain was, therefore, about Rs. 23,250 which sum was divided amongst the shareholders who had formed the corporation to run Kheddas.

October 1919

SASI MOHAN DEB,
Forest Ranger.

Forest Ranger.

BENGAL FOREST SCHOOL.

FINAL EXAMINATIONS—COURSE 1918-19.

This School was started in the year 1906, and it is doubtful whether the results have ever appeared in the *Indian Forester*. It does not pay to be modest and the current year's results might at least be a source of some interest, if not an advertisement.

The Final Examinations were held from the 22nd to the 26th September 1919. The Board of Examiners consisted of Mr. H. S. Gibson, B.A. (Oxen.) D. C. Forests, President, Mr. E. A. C. Modder, E. D. C. Forests, Member, assisted by Mr. E. O. Shebbeare, D. C. Forests, Director of the School, and myself.

Eleven students appeared in the Final Examinations—all passed. No Credit Certificate was awarded—none have been awarded for some years: that is our only consolation!

Seven students were deputed by the Bengal Government, two by the Bihar and Orissa Government, and two by Private States.

The Examiners' Report was very favourable, the standard attained by the class being very level and satisfactory.

Four useful prizes were awarded as follows:

(1) Conservator's Prize for the student standing first, to D. C. Chowdhury, Forester, Bengal.

(2) Examiners' Special Prize for full attendance and shaping well in the Final Examinations, to Deputy Ranger B. Party (Ho), Bihar and Orissa Province.

(3) Director's Prize for the student likely to turn out the Best Forest Officer, to D. C. Chowdhury, Bengal.

(4) Instructor's Prize for Physical Efficiency and Conduct, to N. N. Patnaik, Mourbhanj State. This prize was earned by D. C. Chowdhury, Forester, but it was decided that no more than two prizes should go to the same student

In the unavoidable absence of Sir H. A. Farrington, Bart., Conservator of Forests, Bengal, the President made the awards and gave final instructions to the out-going students, expressing satisfaction at the same time. The other officers present having each spoken a few words *unusual cheers* brought the proceedings to a close.

DOW HILL, KURSEONG:
The 15th October 1919.

S. K. MUKERJI, F. R.,
Instructor.

HONOURS' LIST.

We are glad to see that the following members of the Forest Department figure in the recent Honours' List "for services in connection with the War" published in the Gazette of India (Extraordinary) of 30th December 1919:—

Knight Commander of the British Empire.

George Sankey Hart, Esquire, C.I.E., Imperial Forest Service, Inspector-General of Forests.

Commander of the British Empire.

Peter Henry Clutterbuck, Esquire, C.I.E., V.D., Chief Conservator of Forests, United Provinces.

Officers of the British Empire.

Harry Richard Blanford, Esquire, Deputy Conservator of Forests, Burma

At the same time we are glad to note that the names of the following Forest Officers appear in the recent New Year's Honours' List published in the Gazette of India (Extraordinary) of 1st January 1920:—

Companions of the Indian Empire.

Robert Scott Troup, Esquire, Imperial Forest Service, lately Assistant Inspector-General of Forests, India.

David Alexander Thomson, Esquire, Imperial Forest Service, Deputy Conservator, Bombay.

Rai Sahib.

Mian Budhi Singh, Extra Assistant Conservator of Forests, Punjab.

VOLUME XLVI NUMBER 3

INDIAN FORESTER

MARCH 1920.

SOME NOTES ON MESOPOTAMIA AND KURDISTAN.

AGRICULTURE.

The marvellous agricultural wealth and prosperity of Mesopotamia in ancient times is well known.

Herodotus writes about it that "in grain it is so plentiful as to yield commonly two hundred-fold and .... even three hundred-fold. The blade of the wheat plant and barley plant is often four fingers in breadth," and lest he should be accused of exaggeration he hastens to add: "I am not ignorant that what I have already written concerning the fruitfulness of Babylonia must seem incredible to those who have never visited the country."

As it seems pretty certain that he not only visited the country but examined it minutely when he was there, his testimony, allowing for the usual amount of exaggeration, seems to prove that it was the agricultural marvel of the ancient world. Other ancient writers give an equally glowing account of its wealth.

The whole country, in consequence, was studded with great cities and covered with a network of canals, protective and regulating irrigation works of all sizes, which controlled the waters of the capricious rivers and produced the great harvests above referred to.

After the successive ruin of the mighty empires came the inroads of the various barbarians, Mongols, Tartars and finally the Turks. The whole country fell into chaos, during long periods. The irrigation works went and with them the country's former richness and greatness. The races that inhabited the country disappeared off the face of the earth

Out of and after this chaos the present local and kutcha systems of irrigation were evolved, which lasted to the present time. In 1911 Sir W. Willcocks prepared for the Turkish Government his great irrigation scheme which was to restore Babylonia to its pristine splendour, more or less. His proposals have been recently summarized by Sir G. Buchanan in his articles in the *Times* as follows :—

"Out of the ten to twelve million acres of land which the delta of the two rivers contains the waters of the rivers can only irrigate 7 million acres of summer crops and one to three million acres of winter crops, therefore six areas are to be taken up containing a total area of 3½ million acres. The total cost to be £26,000,000, out of which about half of the expense is on irrigation works and the other half on agricultural works. Sir G. Buchanan estimates the present cost of these works to be £40,000,000."

The great works were planned on something of the same lines as the works of the ancients—the Euphrates was to be controlled by one barrage at Hindyat, upstream of Hillah on the middle Euphrates, at the junction of the Hillah and Hindyat branches of the river, which of course is built and is in working order.

A second barrage was to be constructed at Feluja, with great dependent canal systems.

The excess flood waters of the river were to flow down the Habbania escape, which is partly constructed and which takes off

just below Ramadi into the Habbania lake, a large shallow, shifting area of water a few miles south-west of Ramadi. From there they would be carried into the still larger Abu Dibbis depression, which would act as a reservoir—from this reservoir the waters could be carried back into the river, when needed, at a point near the Hindyat barrage.

The Tigris was to be controlled by two barrages, one in the north at Beled, where the river enters its delta, and the second at Kut. The famous dam of antiquity known as Nimroud's dam was situated near Beled. The surplus waters of the river were to escape from a point above the dam south-west into the Tarthar depression, but this matter was not finally settled.

Provision was made for a system of drainage between the rivers and for afforestation, the great depressions to the east and west of Baghdad being indicated as suitable for this latter purpose.

Sir G. Buchanan, in his recent articles, criticizes the scheme severely as being "mainly a revival on modern lines of old and worn out irrigation systems . ...accepts as a permanency the present degenerate state of the rivers and leaves the vast swamps in lower Mesopotamia to spread ruin and desolation over large areas of country . ..." etc.

As a mere outsider wandering about the country, one is struck by three vital points in connection with the great scheme, *viz.*, the money, the population question and the present state of the land.

Whether or not the necessary money could now be found, in the present indebted state of the world, is a question for financiers and statesmen to decide. The question of population is of far greater importance.

Sir G. Buchanan says that "Sir William Willcocks has visions of labourers from Kurdistan flocking down from the hills ....and then settling in hundreds of thousands to reclaim and cultivate the land," but in Sir W. Willcocks' book no such visions seem to appear; in fact the only remark made on this enormously important point is when, speaking of the day when

the floods are really controlled, he says: "We should see men coming from the West as well as the East and making of the plain of Shinar a rival of the land of Egypt." Who these Westerners and Easterners were to be exactly is not specified; in fact the question is unfortunately ignored.

The total agricultural population of the country has been estimated, it is said, at one to one and a quarter million; the labour question has all along been intensely acute, agricultural wages being even now in many places annas 12 to Re. 1 daily, and at certain seasons much more.

Kurdistan is a country of rugged, rocky mountains and deep fertile valleys. In winter the valleys yield a good crop of wheat, the summer cultivation is rice and tobacco irrigated by the thousands of streams that pour ceaselessly down its hillsides.

The country is extremely sparsely populated, but with good Government, security of tenure and improved communications there seems endless scope for the development and increased production of its valuable crops such as tobacco, and although very few of its forests produce timber a railway through parts of the country might perhaps make the extraction of fuel and charcoal a valuable industry. To attract population from a country like this would be merely to sterilize it for the benefit of the irrigated parts of the plain country.

Equally, there can be no surplus population in thinly populated places like Persia or Asia Minor.

The only possible reserve of population in the country seems to be the wandering Arab tribes—the great nomadic tribes like the Shammar, who live in the northern deserts between the rivers and the Aneiza, who roam in the great deserts west of the Euphrates but who shall say when and how these nomads are to be caught, tamed, and settled down as steady cultivators of the soil? In any case it is likely to be a slow process.

Whether the Government is going to allow immigration of Indian or Negro cultivators is unknown.

Lastly, there is the present state of the soil to be considered Nothing is more remarkable than the stories of the wonderful past

fertility of the land contrasted with its present poverty. The soil is as a rule a stiff silty clay, with a varying admixture of lime, and in most parts of the delta it is strongly impregnated with salts. Often the land looks perfectly healthy, but as soon as or shortly after it is cultivated and irrigated the salts rise with the evaporation and poison the whole show. The country is so flat that there is great difficulty of drainage, and as the soil contains no sand water when once put on is very hard to get rid of.

In contrast to the general theory these virgin soils seem to have deteriorated instead of improved with keeping; many of them are lifeless and waterlogged and need deep cultivation and green manuring to stimulate and aerate them.

The whole country will have to be reclaimed agriculturally by means of systematic and intensive drainage, combined with careful washing to get rid of the salts, and this reclamation in the opinion of some agricultural officers will often be a long and difficult business. It is difficult, too, to know who will do this reclamation, as certainly the present Arab cultivator has no notion of doing it, and whether he will change his lifelong habits seems doubtful.

In lower Mesopotamia the common cold weather field-crop is barley; wheat is the exception, though the Agricultural Department did much during the war to stimulate and increase wheat growing. In the Mosul Vilayet, Assyria proper, wheat is the rule and barley the exception. In Babylonia the yearly rainfall of 8—9 inches in the cold weather helps the growth of the cold weather crops, which, however, largely depend on irrigation, but the semi-nomadic tribes cultivate large areas in the deserts on rainfall alone, raising inferior crops this method is called "daim" or "thiem." The average wheat yield in this part of the country, according to statistics collected by the Agricultural Department during the past two years, is about 550 lbs. per acre or about seven-fold, barley about ½ ton an acre, fourteen to fifteen-fold.

Assyria proper, that is the Mosulese country, is fine rolling wheat land with a good well-drained brown or red-brown soil. The wheat crops it produces on the rainfall alone are much superior

and run up to 1,500 lbs. per acre. The drawback of the country is its general treelessness until the Kurdist hills are reached, when the landscape changes from a rolling cultivated plain into a hill and forest country.

Mesopotamia is remarkable for the numbers of different types of wheat that it contains, which seems probably due to its having been the "cockpit" of the ancient world, and presumably all the different races that lived and wandered about in it each evolved their own types of wheat during their existence on this earth.

The low-lying and marshy parts of lower Mesopotamia are largely given over to hot-weather rice cultivation. Elsewhere the hot-weather cultivation consists usually of melon, lubbia been, sesame, mash or dall cultivation on the sandy foreshores and banks of the rivers. Millet and Indian corn are raised as irrigated crops—cotton is cultivated fairly frequently on the Euphrates as a hot-weather garden crop only.

The Agricultural Department have been carrying out extensive cotton growing experiments on their cotton farms at Baghdad and elsewhere, but the official results of these are not yet published. Parts of the country were celebrated in ancient days for sugar-cane, but the whole thing seems to have died out entirely many centuries ago.

Although as a field cultivator the Arab seems sketchy in his methods compared to the good Indian cultivator, as a market gardener or vegetable grower he is extremely clever and superior, I think, to the ordinary Indian mali. He fully realizes the importance of keeping the soil in good order and well manured, and his methods of nursing early hot-weather vegetables against the cold in carefully covered baskets kept in his bedroom at night and protecting the small plants when first put out and with little windscreens are all very "cute."

The common vegetable garden crops grown in the cold weather are the country spinach (Sillaj), country beet, long white radishes (Fijil), broad beans, turnips and lettuce; these can all be grown better at the beginning of the hot weather when the frosts are over. During the hot months, cucumbers, cabbages,

cauli-flowers, brinjals, tomatoes, watermelons and pumpkins are grown in the gardens with great success. Potatoes give very varying results.

Wherever it is grown, lucerne flourishes as a fodder crop throughout the year and an extremely valuable and paying concern, with the great advantage of being able to grow in fairly salt lands. In no country does lucerne do better, I should think both in quality and yield—but its cultivation is strangely local; as a rule it is largely cultivated near the big towns, but on the upper Euphrates it is entirely absent.

The oasis towns in the western deserts, such as Rahilya and Shifatha, are said to possess wonderful varieties of lucerne, but this has not yet been proved.

In the cold weather the Arabs pasture their horses on the young barley crops; they allow the animals to eat the crop down three times as soon as it reaches about 6 inches in height and then they leave it to grow up.

TREES.

Dates.—Of all the trees, the typical tree of the delta is the date-palm, which abounds throughout, wherever some kind of irrigation is possible. It grows best and is most intensively cultivated on the Shatt-al-Arab round Basra, Fao, etc., where the whole riverside is a continuous belt of beautiful date gardens.

The further north the tree grows the more lanky and weak it becomes, and eventually it peters out altogether about the 35° latitude, near Anah on the Euphrates and Tekri on the Tigris.

As is well known, the tree is diœcious, that is the sexes are separate. The tree is propagated by means of offshoots which spring up in profusion at the base of large trees, the male trees producing male offshoots and the female female offshoots. When about 3 feet high these offshoots are dug out and planted about 80—120 per acre. Each acre of date garden has generally 2–4 male trees.

The number of trees per acre depends largely on what the owner wants to grow below the trees—if he wants fruit trees,

then fewer date trees must be put in; if only vegetables, then more.

The tree has the great advantage that it grows heartily in salt lands and stands everything except excessive drought, snow and some insect pests. When first put out it is wrapped up in hay and straw but afterwards gets perfectly hardy.

It is generally in half bearing in its fifth year and in full bearing about its tenth year. The average yearly yield per tree is about 100 lbs, though some specially fine trees are said by the Arabs to yield up to 500—600 lbs.

No tree yields a bumper crop more than one year in two. The tree is said to live up to 100 years.

The Arabs climb up the trees generally three times a year, once in March to fertilize the female inflorescences by hand by shaking a bit of the male flower over each and tying it in place with a thread; secondly, in September-October to harvest the dates; and lastly, after the harvest is over, to clean up the tree by cutting off the dead lower leaves.

The tree needs a good soaking every ten days during the hot dry months until the harvest.

When the tree is grown up, if the water-table is near the surface it will stand some years without water but produces poor crops of fruit. Generally after two or three years of this it dries up, and large numbers of trees can now be seen at Basra, Baghdad, etc., drying up from this reason.

Once a year, at the beginning of the hot weather, the good Arab date grower thoroughly works the soil at the base of the trees with a spade and puts in plenty of manure.

The varieties and kinds of dates are legion, of all shapes and sizes, of all degrees of softness, hardness, sweetness and colour. Many oasis towns, such as Rahilya, Shifatha in the west, Mendali in the east, are celebrated for the quality and quantity of their dates.

As cocoanuts are described as "the consols of the East," so the dates might well be described as "the consols of Mesopotamia." They are indeed a never failing and dead-certain source

of profit. Nearly every Arab who has made a bit of money aspires to set up a date garden, which will be a source of easy income to himself and his descendants for ever and ever.

Besides the dates the land beneath the trees produces fine crops of vegetables, lucerne, or fruit, as the case may be, and this is a great additional source of income

Every date tree in the country pays a tax yearly to Government varying from 4 annas in the north to Re. 1 in the south, and as the Shatt-al-Arab tract is said to contain 10 million trees this is a pretty useful source of revenue to the Government.

Besides the fruit, which is eaten cooked and raw, the tree has many uses from the fruit is made date-syrup or debbis, also arrack liquor. From the midribs of the leaves are made good local beds, chairs and small tables, and these articles are also extensively used as roofing material From the split leaves are woven excellent "Chatai mats,' all kinds of sacks, bags and baskets, and on the upper Euphrates at Hit water pots which are water-proofed with bitumen. Useful cordage is made from the fibrous sheaths at the base of the leaf-stalks

The dry bases of the leaf-stalks are cut off and furnish a fair fuel. The wood of the tree is much used as beams for the flat house roofs, also for rustic bridges and culverts. It is sometimes used for fuel but is, as Doughty says, "as vinegar to the teeth and smoke to the eyes in burning.' No wonder, with all these benefits, that the Prophet Mohamed enjoined his followers to honour and cherish the date-palm as their uncle.

In spite of detractors, Mesopotamian dates more than hold their own in the world. There is, of course, a huge export of dates from Basra to America and England, which, brought in dried, are pressed by hand into wooden boxes, each box containing about 80 lbs. of dates, a convenient cooly-load.

The boxes themselves come out from Sweden, ready cut up in sections and are made up in Basra. It remains to be seen now whether India with its wealth of wood and industrial awakening can now supply these.

Three kinds of dates are shipped from Basra --Halawi, Khadrawi and Sair. Of these only Halawi go to America, because the Americans for some aesthetic reason only care to eat yellow dates. The demand for Basra dates as a cheap wholesome food in the outside world is ever increasing, in spite of North African and American competition, and as Sir W. Willcocks has pointed out huge markets such as China lie untouched. It is difficult, too, to understand why dates have not caught on as food in India, specially in Western India which lies so handy.

Up-country among the settled population only the poorest classes eat date as their staple food. The great customers of the date-growers are the nomadic tribes who come in once a year from the deserts to sell or barter their live stock and wool and to receive in exchange dates and other necessaries of life.

The statistics and economics of date-growing in Mesopotamia have not yet been properly worked out -one Agricultural Officer was recently engaged in doing this round Basra. Round Baghdad it is stated that every decent date tree in full bearing is worth Rs. 5 per annum clear. The pre-war price of dates was usually annas 2 to annas 4 per hugga (2·7 lbs., roughly anna 1 per lb., and as the average yield of one tree annually is 100 lbs. this makes Rs. 6-4 annually per tree. Allowing for taxes and expenses, this figure does not seem unreasonable. Thus every acre should bring in Rs. 500 yearly from the dates, and this income ought to be doubled if the soil beneath the trees is intensively cultivated with fruit trees or valuable garden crops.

FRUIT TREES.

Irrigated, walled in fruit gardens are a great feature in this part of the world, the fruit trees being grown generally between and under, or mixed up with, date-palms. The gardens themselves are often not tidily laid out but present a confused jumble of many kinds of trees.

Oranges, sweet limes, apricots, peaches, nectarines, pomegranates, figs, mulberries, apples, vines are all commonly cultivated, pears and little purple plums less so.

The Zizyphus Spina-christi, the sidra or nabbak tree is grown everywhere for its fruit and develops into a fine large spreading tree.

The mulberry is grown as much for its timber as for its fruit. The timber is used in house-building, boat-building and all kinds of purposes. The large wooden irrigation wheels, 40'—50' in diameter set in the river on raised aqueducts, which are such a feature on the upper Euphrates from Hit northwards are all made of mulberry pieces fixed together with wooden trenails.

The olive tree is found sparsely here and there in the gardens of lower Mesopotamia but in the north it is very common and fine old groves of olives occur.

Round Mosul there are many orchards of pistachio trees, planted in neat lines with several yards left in between for crops.

Many vineyards are found in the Mosul Vilayet and on the Kurdish hillsides and country wines are manufactured by the Christian and Jewish inhabitants; excellent dried raisins are plentiful.

Amidst such diversity of fruit culture, it is curious to find so little grafting and budding practised while the pruning, training, etc., of fruit trees is almost unknown.

The large-leaved black mulberry is budded on to the small-leaved white kind, oranges are budded on to lime stocks, limes are budded on to seedling stocks.

All the rest of the fruit is from seedlings or cuttings and produces a good cooking article but not much more than this.

Baguba on the Diala river about 35 miles north-east of Baghdad is a veritable garden-city and it is there that orange culture reaches its greatest development, and certainly these oranges are inferior to few in the world in size and flavour and fetch very high prices in the Baghdad markets.

FORESTS.

There is a strong tradition in Mesopotamia that formerly, in ancient times, the country was well covered with forests Modern authorities repeat this legend, thus Sir W. Willcocks writes

"Mesopotamia must at one time have been covered with dense forests since even to-day, in spite of the Arabs and their flocks of goats and sheep, one meets in the deserts some fine specimens of the Nebek or wild plum tree," and Rawlinson remarks, "There is reason to believe that anciently the country was very much more thickly wooded than it is at present."

It is not known how this tradition started, for ancient writers themselves do not seem to bear this out. Thus Xenophon describing Assyria says, "The country was a plain throughout even as the sea, and full of worm-wood (*i.e.*, thorny scrub); if any other kinds of shrubs or reeds grew there they had all an aromatic smell but no trees appeared"......while Herodotus describing Babylonia makes no mention of large forests which he certainly would have, had they existed; he even says, "it makes no pretension indeed of growing the fig, the olive, the vine, or any other tree of the kind"......he comments, however, on the enormous numbers of palm trees.

We know that the rainfall in ancient times was a scanty cold weather one, even though it may have been a bit heavier than it is now; and as there is seldom any rain at all after the middle of March when the trees start growing and want water, it seems almost impossible that there should have been large forests in the country except as riverain belts along the rivers, getting their annual dose of water regularly every year from the floods in March, April and May. Moreover the wild animals which roamed over the wide plains in the past, the wild-ox (probably of the American bison type) the wild-ass, the gazelle, the ostrich and the lion were not such as would delight in extensive heavy forests, though the lion of course would like scrub and riverside thickets for cover to lie up in.

At the present day, the forests are chiefly conspicuous by their absence.

The two forest trees of the country are the Euphrates poplar (*Populus euphratica*) and the willow (*Salix babylonica*) which occur in small belts along the rivers, generally at the curves and bends of the rivers and on the islands.

Such forests are much more common on the Euphrates than on the Tigris.

They often have undergrowth of Tamarisk and camel-thorn *(Prosopis Stephaniana).*

They are formed by the deposition of seed brought down by the waters. Once the young trees have established themselves they increase and multiply by throwing up many root-suckers.

The commonest tree of the two is the poplar. It grows at a great pace, about one inch in diameter a year; when young it grows straight and whippy, but after the 4th year or so it often assumes a twisted crooked habit and many trees sprawl about in curious attitudes

Both trees grow to great size if allowed to, but they do not often get the chance as the Arabs hack continually at them throughout life, for want of other wood.

Both trees coppice vigorously when cut, and reproduce fairly easily from cutting.

The wood is fairly good when straight and is used much for building huts and as timber for the charrads or water-lifts from the river. Of the two, the poplar wood is the tougher and better quality. As fuel both woods are moderate, when dry.

Between Ctesiphon and Kut on the Tigris, a distance of about 75 miles as the crow flies, there are almost continuous areas of brushwood forests on both banks of the river.

These areas are very extensive and in spite of their humble character valuable, as the brushwood which they produce forms the main fuel supply of Baghdad city and is also the chief source of supply of revetting material for the numerous bunds round about and near the city.

The "Forests" consist usually of a dense belt of Tamarisk and camel-thorn on the riverside, growing up to 9′ in height, and behind this thinner and shorter thickets of Tamarisk, camel-thorn, liquorice and thorny bushes.

No trees occur, though one private forest, with an excellent growth of poplar, is situated about half-way down. It belongs to a large land-owner by name Dawood Beg and he is said to make an income of Rs. 4,000 monthly from it.

A rough working plan has been made for these forests, on a four years' rotation and they are yielding a yearly income of Rs 30,000 to the Government, in their present state—the material being cut and carried to Baghdad for fuel by contractors in Mahalas or country craft, while some forests are reserved for Government departments needing revetting material.

It is very probable that there was much more riverain forest and scrub, along the rivers even up to recent times. Some Arabs attribute the comparatively recent extinction of the lion to the fact that so much cover along the river banks has disappeared.

Messrs. Lynch s steamers, when they first started, are said to have been run on fuel and to have caused the destruction of much woodland on the river banks.

On the Tigris north of Samarra there is practically no growth at all on the river till Mosul is reached. Opposite Mosul town there is a large " forest " about 3 miles long and 2 miles wide, which has been ruined by the Turks and now only contains Tamarisk scrub.

All these types of jungle are dependent on the flood waters for their existence; dry forests existing on the rainfall alone are practically unknown. One such forest does occur on the eastern boundary of the Amara district at the base of the Pusht-i-Kuh mountains. It consists of a range of sandy hills 8 or 9 miles long, covered with a fair growth of Eithel trees, 20—30' high. This Eithel is probably *Tamarix articulata.* The area is very inaccessible and unexplored at present.

The liquorice plant (sus) is found almost everywhere but is noticeably absent on the Euphrates above Feluja. It extends into the valleys and water-courses of Kurdistan. It grows about 6' high, has a pretty little leguminous purple flower and a small pod It dies down annually underground and forms a tangle of roots, the thickest of which run up to 3 inches in diameter. It occurs in largest quantities on the Tigris in the scrub forests between Ctesiphon and Kut occupying large areas of country on the river banks.

It is exploited solely by an American firm who employ agents to get the local Arabs to dig it out. It is shipped to Basra, taxed by the Government and exported to America for flavouring the tobacco and other uses.

The local people make no use of it whatever.

Forest conditions in Kurdistan are entirely different; it is a hill and mountain country with a severe winter and considerable rainfall extending up to May. A large part of the mountains and uplands is covered with forests which consist almost entirely of various kinds of evergreen oaks.

The whole character of the woodlands is scrub, or semi-scrub, of thin to moderate density.

The oak trees grow from 15'—40' high, with large spreading crowns and thick twisted gnarled boles, often with an undergrowth of juniper. There are probably many different kinds of oaks but three are easily distinguishable, *viz.*, the baloot, which has large leaves and produces the baloot or edible acorn, the afs or mazuye oak with smaller leaves producing oak galls, oak apples, of which the acorns are small and not edible, and the dindaw, the margins of whose leaves are almost entire which produces nothing of economic importance.

A small percentage of other trees are found, of which a hawthorn tree and a maple are conspicuous. There are many undershrubs, with edible fruits.

The baloot or edible acorn, about 2 inches long, is much eaten by the wilder poorer Kurdish tribes living in the uplands who mix it with wheat flour and bake a black bitter bread from it; they also eat it roasted whole and it has then a fair nut-like flavour.

They practise in parts shifting cultivation in the stoney soil, stripping the trees of small branches and leaves, burning and cultivating in the ashes. In summer the oak trees are extensively lopped and stacked for dry sheep fodder during the winter.

The baloot is taken to the local markets regularly as an article of food.

The acorn-cups are collected and used for tanning.

The afs or mazuye, oak galls, form a very important article of commerce throughout an enormous area of mountain country from Southern Persia up to Lake Van and possibly beyond The galls are produced during the hot-weather months and gathered in September-October. They are gathered in four pickings, at each picking the gall has a different colour, starting a light khaki colour and finishing up dark green. The last picking is said to be the best.

The Kurds bring them into the local markets, where the local merchants grade them and buy them. They are subjected to an export tax of 12½ per cent. on their current local value and then exported on pack transport. They are sent all over the world, even to England and Europe.

The oak apples, about the size of a peach, of dark red-brown colour are similarly brought in and disposed of.

They are much less valuable for tanning purposes, and are said to be largely sent to Persia. They have, it is said, a value in medicine in that country. However, in the Kurdish parts of the Mosul Vilayet, the Jewish cobblers use nothing else but these apples for tanning the rough leather of which the local shoes are made.

A still more valuable minor product of these forests is the gum tragacanth. It is the gum tapped from the roots of various small spiny *bushes which grow on the higher plateaux and* mountains. Specimens of some of these bushes and gums have been sent to the Forest Economist who states that they are species of Astralagus and Acantholimon ; details regarding the methods of tapping, etc, have also been supplied to him.

The best quality gums are in semi-translucent flat white flakes, while the poorer the gum the browner in colour it gets.

These gums are most valuable for sizing cloth and the bulk of them go to Europe, some part goes north to Persia and Russia. The present price of the best quality gum in the London market is about £1,200 a ton, according to a recent wire received by a Baghdad dealer. All gums pay a 12½ per cent export tax at the collecting centres like the galls.

In the valleys and water-courses the forest vegetation is quite different; there are found large spreading chinar trees, ash, Euphrates poplars, willows, liquorice plants, large, wild or semi-cultivated walnut and buttom trees—these latter two trees near the villages.

The buttom tree is, so the Forest Economist states, probably *Pistachia mutica* It is stated in Brandis' "Trees" only to grow to 25' here it is a large fine tree up to 60' high. Its seed is a common article of food and yields an oil. Its bole is largely tapped for a brown gum, which is much less valuable than the gum tragacanths; there is a large export trade of this gum in parts to Aleppo for sizing cloth, to Baghdad for the same purpose, and also for chewing gum and other uses.

All the valuable gum and gall trade seems to be in the hands of inhabitants of the country, as well as the valuable foreign export trade of these commodities. European firms do not seem to export much except dates, wool and some grain.

The great collecting place of these articles is at Suleimanie, the chief town of the Kurdish district of that name, about 180 miles north-east of Baghdad, where the trade is highly developed. In the northern portions of the Kurdish country gum collections seem entirely non-existent. Gall collection is universal.

Occasionally here and there valleys occur, full of pure pine forest.

The Kurdish pine resembles the Aleppo pine, it grows thinly up to about 40' in height and natural regeneration is poor. The tree is extraordinarily local—one beautiful pine valley occurs at Zameetha, a place about 60 miles north-east of Mosul, on the way to Amadia The tree yields serviceable small timber.

The Lombardy poplar (kawakh or spindar) is cultivated extensively throughout Kurdistan; every little village has its small plantation watered by the streams.

This tree is almost the only one which is planted exclusively for timber—it is fairly common in the gardens round Baghdad, more so in the gardens on the Diala river and its tributaries and still more plentiful in Kurdistan. Vast quantities of poplar pieces

are rafted down yearly from Asia Minor to supply Mesopotamian markets.

It is the commonest balli in the country; its chief use is for flat house-roofing and the thin poles, as punt-poles on the rivers. It is the only timber exported from the Kurdish hills into Mosul cut up into split 8 lengths, one on each side of a pony or mule.

It is a most paying tree to grow; large cuttings are put in at 3′ × 3′ square, which strike readily if given plenty of water, in the hot weather. Its growth is most rapid and it is generally felled in its 7th or 8th year. Ballis 1′ in diameter and 15′ in length often fetch Rs. 20—25 apiece.

The wood is white, light, of moderate strength and of course perfectly straight.

Except for this poplar planting, arboriculture is very little practised anywhere; occasionally the Arabs plant the Eithel tree (*Tamarix articulata?*) in avenues. A few Eucalyptus, Siris, Sissoo and other trees may be seen planted in the gardens. Mosul has a fair variety of trees mostly exotic planted round the town.

Arboriculture is a pressing need in the country and a central arboriculture nursery is in full swing at Baghdad with branches at Mosul, Hilla and Amara. In these many kinds of Indian and Australian trees are being tried.

MINERALS.

By far the most important mineral in the area is oil, represented by the world-famous oil-fields in the Ahwaj district.

The Anglo-Persian Oil Company is at present developing another oil-field in the Khanikhin district.

Next in importance and closely connected with the oil is the bitumen which plays an important part in the economic life of the country. This mineral which is a form of crude oil thickened with various sulphurous compounds is found in many parts.

It is found in the Pusht i Kuh mountains, and in Kurdistan but its best known localities are on and near the Euphrates and on the Tigris.

All bitumen springs, great or small, give forth the same things, namely, water strongly impregnated with sulphur, flakes of liquid bitumen floating in this water and sulphuretted hydrogen gas (at least it smells like that) The surfaces of the springs continually bubble and seethe with the ascending gas.

In the Euphrates area there are three or four springs and deposits in the western deserts The best known of these is Aboo Jir (the father of bitumen 30 miles W. of Ramadi.

The Aboo Jir deposit consists of seven or eight small springs about 3′ in diameter, carrying away the liquid bitumen called Sayalli; this liquid bitumen eventually solidifies into a hard knobby deposit called gasst and this hard crinkly deposit covers the whole country for about 2 square miles, and up to 2′ in thickness Owing to its inaccessibility it was unworked before the war, but before the capture of Hit all the donkeys of the deserts were organized for bringing in the stuff, camels also being used.

In the cold weather wandering sections of the Dilaim tribe live on these springs, drinking the abominable waters and irrigating meagre barley crops from these springs.

Another curious deposit is at Awasil, a few miles north of Aboo Jir, where there is a flat deposit of gasst bitumen covering about 1 sq. mile, about 1′ in thickness.

This gasst is plastic, about the consistency of chewing gum.

These deposits present a very striking appearance, looking like huge blots of ink in the white deserts.

The most striking place for all kinds of minerals on the Euphrates is Hit, a very old and curious little town about 35 miles north of Ramadi on the right bank.

Here the geological formation of the whole of this Euphrates country for many miles is well shown. It consists of a solid horizontal core of limestone, slightly rippled in places, above it layers and outcrops of gypsum, which varies from transparent rock-like crystal to opaque rock, like limestone.

Through this limestone and gypsum the bitumen was forced under immense pressure, and at Hit this process is well illustrated as the whole countryside consists of weird black and white cliffs

and rocks often with fantastic patterns, producing unreal futurist-like pictures.

Hit and its surroundings simply ooze with bitumen; seepages and springs occur everywhere from the size of a pin prick up to 10 yards in diameter.

The country abounds also in sulphur springs of all sizes coated with pink and yellow deposits, the atmosphere is vitiated thereby, and when the wind is in the wrong quarter, horrible odours arise, like the breaking of millions of rotten eggs, from the sulphur-sodden soil.

Very ancient and curious industries are established at Hit, in connection with the various minerals found there. The first which may be cited is the bitumen-boiling industry

This industry was evolved in order to produce a hard heavy asphalt suitable for most purposes.

Two baths are built side by side, with a partition in between of stone and mud; below these baths a furnace is hollowed out and at one end a rough chimney.

The floors of these baths are very odd. Broken chatties are fitted into one another endwise to make round bars across the floor like those in a grate, above this is spread a layer of clay and above this a layer of liquid bitumen.

The furnace is then heavily fired with liquid bitumen, the supporting "bars" drop down leaving the baked crust of the floors.

Each bath is roughly 7′ × 4′ × 2′. It is filled with all kinds of bitumen first, a layer 3″ deep of liquid sayalli, then a mixture of Aboo Jilail, an inferior earthy bitumen and gasst, and the whole mixture is boiled up violently into a seething brew, with liquid bitumen as fuel, allowed to simmer down and a peculiar earthy substance called swaad is put in as a flux in a layer 2′ 3″ deep.

The bitumen boilers stir and rake the mixture continually, one man pushing a spade, the other man pulling with a rope attached.

This boiling, simmering down, raking about process and at times adding swaad, goes on until the expert pronounces the mixture as ready, it is then spaded out alongside the kiln and

allowed to cool and harden, producing a hard heavy asphalt-like substance known also as swaad with a clean sparkling fracture. The swaad earth itself, which is dug up, is usually reddish brown in colour and seems to be a mixture of lime, gypsum, sulphur and earthy substances.

Generally speaking the time needed for producing the boiled article is three days. But this varies (if properly made swaad, when applied to any substance, sets and remains as hard as iron in any temperature)—unfortunately the modern "Hittites" are noted for their cheating propensities even in a land where most men are pretty useful at swindling and they often palm off a very inferior article.

Swaad when applied to anything is broken up into small pieces, heated in a tin or small kiln and then rolled on in layers with a greased rolling-pin like a cook rolling pastry. There is fair skill needed to do good work and many Arabs throughout Mesopotamia are experts at it.

Hit is a real black bitumen city—fairly coated with bitumen—everything that can get a coating of bitumen gets it.

The flat roofs of the houses are black with it, so are the floors of the rooms, the streets, door-steps and window sills. The Mahalas, *i.e.*, country boats and round basket-work boats, goofas, are covered with it here and everywhere else.

The water pots, jars, plates, baskets in Hit are all water-proofed by smearing them with liquid bitumen, which dries hard pretty quickly. From Hit all kinds of bitumen are exported right down the Euphrates in large square-ended home-made coracle boats called isthbias, made of rods and withies, thatched outside with grass and, of course, bitumen-covered. Large quantities are also sent overland to Baghdad.

It was of very great value to the M. E. F. enormous quantities were used instead of cement for water-tanks, all the country made bridge boats were coated with it, as were the floors of hospitals and buildings and the inside of water channels.

No foreign export of bitumen exists, but it is difficult to understand why it should not be imported into India and serve

many useful purposes. At present Trinidad bitumen is used to a limited extent in India for making black roads in a mixture, and for water-proofing cables; it is imported into India *via* England. Probably, some day, some enterprising person or firm will make a fortune out of these Mesopotamian deposits.

The price of the swaad asphalt mixture on the spot is Rs. 15 per ton, other natural bitumens about the same and liquid bitumen annas 12 to Re. 1 per kerosene oil tin.

This bitumen business at Hit is as old as time, much older than the prophet Job, who, after all his troubles, lies buried there. The bricks in the walls and houses of ancient Babylon city are all laid in bitumen from Hit with a thin layer of chitai between the brick and the bitumen, which crumbles away into dust on exposure but leaves behind its pattern on the bitumen.

Possibly the best known bitumen springs are those at Gyara, on the Tigris about 30 miles south of Mosul, where both crude oil and bitumen occur, and where the Turks had an oil-refining plant in working. These are described by Layard and other travellers, being on the main road between Baghdad and Mosul. From these springs bitumen is taken all over the Mosul Vilayet. They have even figured in a recent modern novel "Miss Haroun-al-Raschid," which gives an interesting account, full of local colouring of the Mosulese country and at the end of the book the villain makes a false step and is dramatically drowned in the black and bubbling depths!

Both here and in the western deserts the Arabs at times fire the springs with brushwood thereby producing enormous pillars of fire and dense black smoke; the reason for this is unknown but they say that it is to prevent the springs getting choked up with the accumulated scum of bitumen.

With the abundance of bitumen on the Euphrates it is curious that only one seepage of crude oil appears on the left bank, 12 miles north of Ramadi, in a pit some 15' deep. The flow is very small and the owner of the soil makes a good thing out of it, selling it as an antiseptic dressing for camel-sores to the camel drivers, all over the area.

Building materials except clay for bricks are very scarce and practically non-existent in lower Mesopotamia, and it is fortunate that they are abundant in the upper parts of the country.

Lime is found and burnt at Kerbela, a good limestone quarry exists at Ramadi, but the chief source of supply on the Euphrates is at Hit where all kinds of limestone occur, some of fine hard consistency making excellent building material.

The limestone at Hit, used for burning lime is jet black, impregnated with bitumen, which oozes from it like thick drops of blood from a vein. The lime kilns are cleverly constructed above ground, from blocks of limestone, large at the base and gradually getting smaller up to the top, leaving inside a hollow chamber. Fired with liquid bitumen, the stone helps to burn itself and produces an excellent lime, exported to Baghdad and all over the Euphrates area.

Elsewhere lime is burnt in closed kilns with brushwood as fuel. Mosul abounds in minerals, possessing excellent building stone lime and gypsum. Much marble is quarried in its vicinity, and used in the ornamentation of gateways of houses, etc It is a coarse white marble with black streaks, and is considerably exported to other places.

Gypsum is a great feature of the upper country, and outcrops of it occur over great stretches of country. It varies much in character, being found in parts as an impure earth mixed with clay and lime, often as pure transparent rock-like crystal and in all forms of opaque white, or greyish rocks.

It is a great help to the local inhabitants in all kinds of house building. As the climate is very dry, they use it above ground instead of lime mortar, although it is not impervious to moisture and crumbles eventually.

It makes building extraordinarily easy, as the burnt gypsum is used simply mixed with water and sets hard immediately.

Thus they build large arches, without any kind of centring or support; first of all making the outside ring of the arch on the ground, then sticking it up in place and completing it.

It makes a splendid wall-plaster, white or grey or brownish, according to its variety, and is used throughout the land.

It is burned in the same way as lime in closed kilns with brushwood in most places, and at Hit with liquid bitumen as fuel in open kilns similar to the lime kilns. Here the rock is streaky black and white.

The gypsum earth, found in many places in the desert, is burnt simply by spreading stable litter or rubbish on the surface and burning it; this produces also a very serviceable article, for plastering and other works

Coal is fairly common in the north-east.

The coal mines at Kifri were extensively worked by the Turks during the war. They transported the coal on a 2′ line in Decauville trucks with oil tractors, to a place called Sindyah on the Tigris, a distance of some 50 miles. The mines consist of a deep shaft which they flooded on leaving, they also set fire to all the stuff on the surface and it is still smouldering away.

Thin seams of coal can be seen in parts of Kurdistan, but all the coal in this part of the world seems to be soft, third rate stuff, of no great value.

Copper was it is stated, worked in ancient times in Northern Kurdistan, and the presence of large areas of red rocks and red soil indicates some kind of iron oxide rocks, probably of no economic value.

Ordinary salt deposits are very extensive in places in the western deserts; the cost and difficulty of transport are the only impediments to their more regular and extended working.

Hit possesses, in its near vicinity, a small brine spring, from which during the hot months the water is run into pans and evaporated, producing excellent white salt. The pans themselves are naturally lined with bitumen, which makes them absolutely water proof and the process of formation of the white salt on the black bottoms of the pans is curious to behold.

Being quite close to the river, this salt business is very valuable and could with care be largely developed and extended.

Except to a very limited extent at Hit sulphur does not appear to be worked anywhere, although so much of it lies about the bitumen springs.

Different kinds of clays for brick-making and pottery abound. The chief difficulty in brick-making is very often to get the salt out of the clay and the ancient bricks are generally superior to the modern ones in this respect.

The Military Works Department has extensive brick-making operations in progress near Baghdad, using oil as fuel. The ordinary fuel for bricks is brushwood.

Good pottery clays exist on the upper Euphrates; there are beds of attractive pinks and yellow clays from which good local pottery is manufactured.

D. BOURKE, I.F.S.

EXTRACTION OF TIMBER IN TASMANIA.

BY CAPTAIN G. C TEMPLE COX.

[PHOTOGRAPHS BY MESSRS. BEATTY AND SONS, HOBART, TASMANIA.]

The island of Tasmania is well timbered and possesses valuable hardwoods, certain species of Oak, Pines, in addition to the Eucalyptus gums, and Blackwood for which the Island is usually noted.

Several years ago I had the opportunity of visiting, as a sightseer, one of the forests, situated near the mouth of the Huon river, where the extraction of timber was being carried out on an extensive scale. The work was concentrated and the fellings heavy, thus allowing the installation of elaborate plants for the removal of timber.

System of work.

The usual system of work in a Tasmanian forest is to fell and log in the valleys, haul up the logs to the high ground by steam Donkey Engines, despatch the logs by log train to the saw-mills where they are converted according to requirements. The mills are usually situated on the banks of a river, or on the coast, and the converted timber is shipped to the capital for export or local utilization.

Labour.

The Tasmanian axemen hold a very high reputation for skill. They take the same care and pride in their axes that crack Bisley shots

do in their rifles. At a Chopping Competition, the four feet chop is a question of seconds, the time is taken by stop-watch and the start and finish is flagged like a horse race.

The felling teams usually consist of five men and combine axe and saw. A platform is erected on the doomed tree at ten to twenty feet from the ground. The workmen fell from this platform and only quit when the tree has been felled. In this way trees of even giant girth can be thrown exactly where required, without the use of ropes; though in special cases ropes are used. The stump is then sawn through flush with the ground; the subsequent logging being the work of the log team

Logging and Loading.

As soon as a tree is felled, the logging team get to work and log to the required length with logging saws The steel hauling cable is then hitched on and a steel plate, called the shoe, is placed under the nose of the log; the shoe enables the log to ride obstacles. (See Frontispiece which shows the method of hitching on the hauling cable and the shoe in correct position.)

When the shoe is not used, a torpedoed steel crate, called the cradle, is fitted over the nose of the log which acts in exactly the same way as the shoe. While a log is being hauled up to the log train it is accompanied by a man with a pair of horses or oxen, this team helps to guide the log over and round obstacles, and drags back the cable as it unwinds from the hauler to pull a fresh log. The hauled logs are lifted on to the log train, by steam cranes—some of these cranes are combined crane and hauler. The logs are then taken off to the saw mills by the log train, with the loading and unloading crew. Fig 1 shows a wagon load on the log train.

The mills.

The log train "draws up" under an overhead Trolley-crane which removes the logs from the trucks and places them in turn on the sawing platform. Once a log is on the sawing platform, everything is done automatically, until the converted timber is shot out into the stacking yard. The logs are squared by band saws, pass along movable platforms to the circular and upright saws, where

Frontispiece.

Hauling logs through the forest.—Tasmania.
(Reproduced by kind permission of Messrs Beattie and Sons, Hobart).

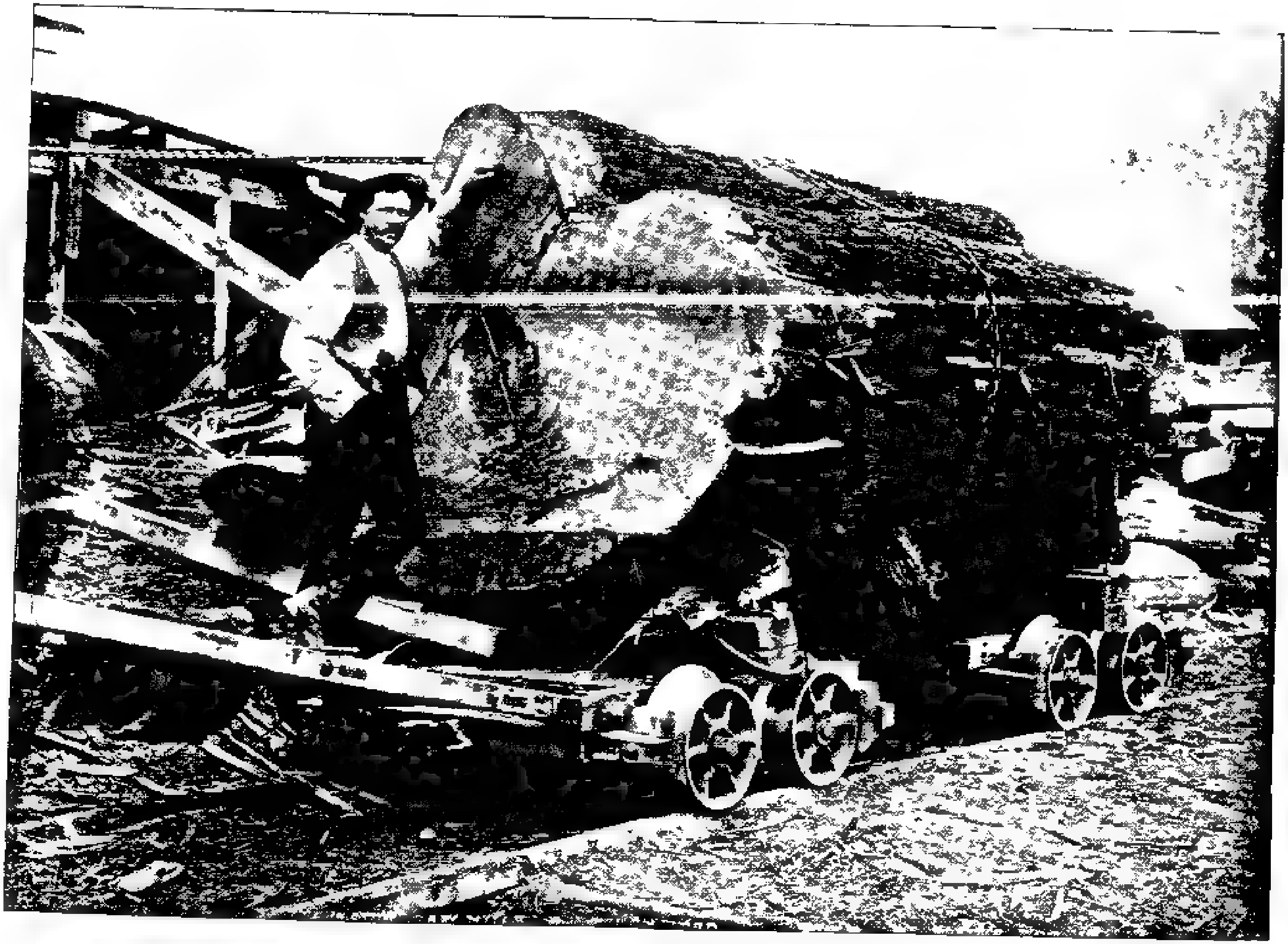


Fig. I. A wagon load on the log tram.
(Reproduced by kind permission of Messrs Beattie and Sons, Hobart).

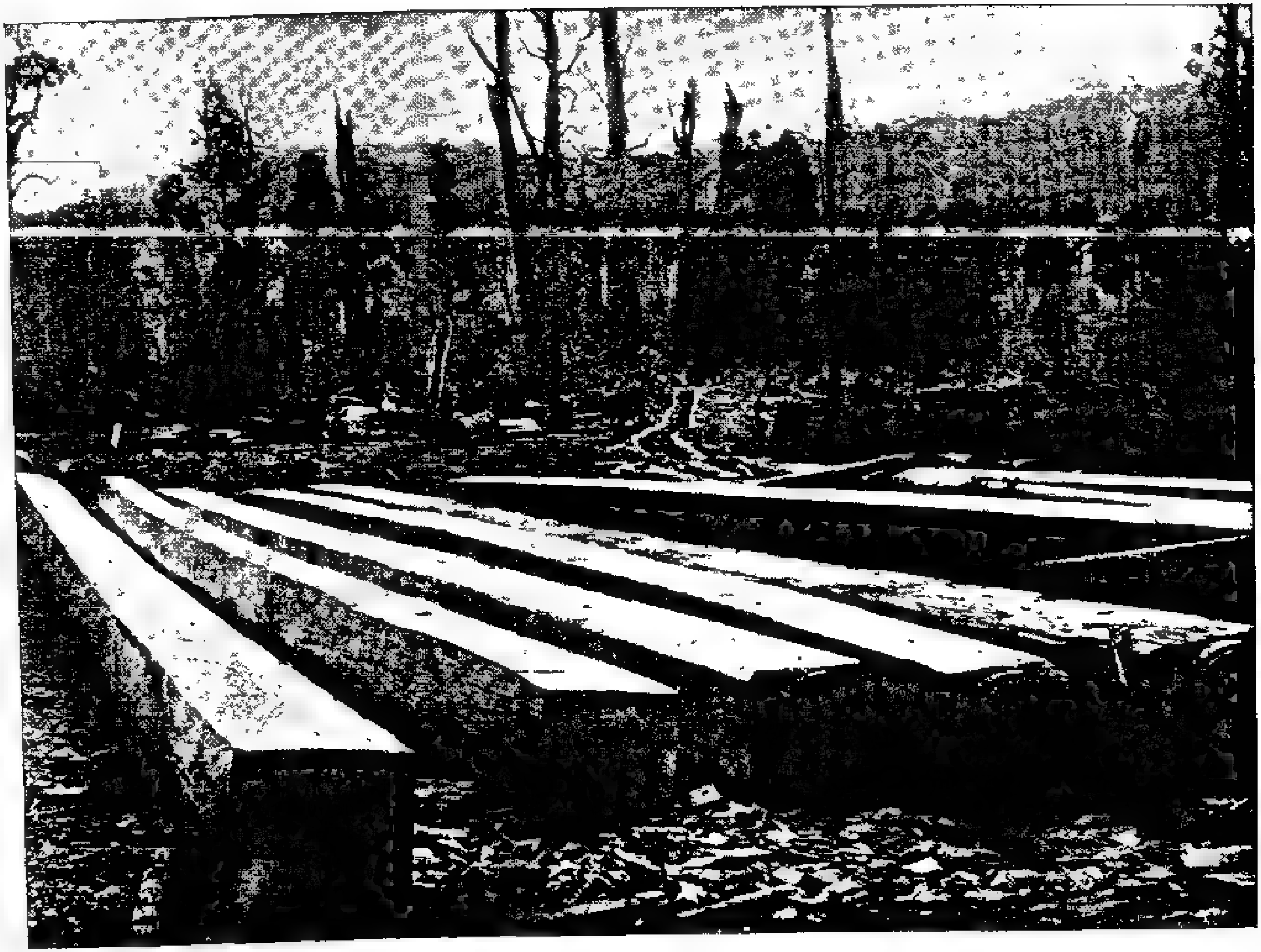


Fig. 2. Axe-squared baulks for piers (Note the heavy wastage of timber).
(Reproduced by kind permission of Messrs Beattie and Sons, Hobart).

they are automatically sawn to the required lengths, thence through the frame saws for correct breadth and depth along a Chute and into the stacking yard. The side pieces, uneven lengths, etc., are automatically run off on to a second platform where they are dealt with according to requirements. Sawdust and chips are absorbed into the furnaces. The wastage is nil, for the branches of the trees and chips from felling are used as fuel for the haulers.

Fig 2 shows axe-squared baulks that were extracted for the construction of a local pier, from a forest where there were no mills. The baulks were dragged by teams of oxen to the river bank The wastage of timber in chips was enormous

OBSERVATIONS ON SOME EFFECTS OF FIRES AND ON LIGHTNING STRUCK TREES IN THE CHIR FORESTS OF THE NORTH GARHWAL DIVISION

Effect of Fires.

I have been reading Mr. Champion's interesting article in the July 1919 number of the *Indian Forester* in which he gives the results of some of his observations on the effect of fires in chir forest and I am tempted to add a few remarks from my own experience in North Garhwal.

The fires of 1916 were as widespread and disastrous in Garhwal as they were in Almora, in fact out of 150 square miles of chir forest very little indeed escaped. These forests had for the most part been successfully protected during the previous two seasons and during this period fellings on a modified group system had been made over a large area. The débris from the fellings had collected in masses mainly round the bases of stems bordering the lower edges of the groups, and when the fires of May 1916 swept through the forest these trees were subjected to a conflagration of such intensity as could never occur in a forest under natural conditions.

Early in 1917 it was found that large numbers of trees were dying singly throughout the greater portion of the area burnt, but though scattered trees could be found in almost any portion of the

forest the greatest damage was confined to trees bordering the filled groups, especially along their lower edges.

Up to January 1918 the trees were still dying at apparently the same rate as they had done at any previous period since the fire occurred, but 1919 has shown a very marked decrease and it is reasonable to suppose that in 1920 the death-rate will be almost normal again. From general observations it appears that death as a rule takes place between November and February ; at least this is the time the needles wilt and fall though the cambium in the stem near the ground may have been dead for some time. The above remarks refer entirely to large trees.

Mr. Champion draws the conclusion from his observations that even the largest trees cannot withstand a bad fire when conditions are against them. Unless my experience has been somewhat different to Mr. Champion's I think the above statement is liable to some misunderstanding. From my own observations I scarcely believe any fire could kill trees over 100 feet high unless artificial débris had been lying round the tree base or the base of the stem had been previously injured and the injured portion had caught fire.

Under normal conditions where the inflammable material is restricted to pine needles and grass I think no sound stem over 100 feet high could suffer more than the loss of a few of its lower boughs up to a height of say 60 feet from the ground.

From Mr. Champion's article I conclude that he thinks the chir trees which continue to die in years subsequent to the fire are still dying from the direct effects of the fire and that insect attack plays a very secondary part. He says it appears that from some cause or other the gradual death of the cambium results, and when this has circumscribed the trunk the whole tree dies ; and later he says that insects were not numerous enough to make full use of the available material so that dead and dying trees practically free from insects could be found.

Whilst agreeing that trees which die during the first 12 months after a fire has occurred will probably be dying from the direct and practically unaided effects of fire, I think

it improbable that this would continue into the second and subsequent years without the assistance of some subsidiary cause, such as insects or fungi. In any case I have invariably found severe beetle attacks in all the dying trees I have examined. *Platypus biformis*, Chap., was by far the most generally distributed and numerous of all the beetles observed. Mr. Champion's observation that this beetle can never be considered a primary cause of death was not, I believe, borne out by what I saw, and I have two records where this beetle seemed to have undoubtedly attacked absolutely healthy trees. *Cryphorrhynchus brandisii*, Steb., was found the commonest species next to *Platypus biformis* and I found it present in trees the cambium of which was not completely dead, though I never found it in an apparently healthy stem as was the case with *Platypus*. *Poligraphus longifolia*, Steb. and *Polygraphus major*, Steb., though not so common as the above, were also not uncommon. *Ips longifolia* was only twice collected and was comparatively rare

To what extent parasitic fungi play a part in causing the death of trees is certainly a matter which ought to be further investigated. *Fomes pinicola*, Clke., is not uncommonly present in trees which have just died but I could collect no evidence to show that it had been a primary cause of death, in fact the evidence was mostly the other way.

Effect of Lightning.

Mr. Champion has made a casual remark to the effect that chir trees go on gradually dying round a lightning-struck tree and in para. 30 of the administration report for the United Provinces for 1917-18 I find the following remark: "The effect of lightning in chir forests is worth observation. After the trees which were actually struck by lightning have died the surrounding trees often gradually become affected and in their turn die until groups of 12 to 20 large dead trees are to be found."

I have for some time past made observations on lightning-struck trees and a few remarks *à propos* of the above quotation may be worth recording. I will briefly describe from my own

experience the visible effects which may be produced by lightning on chir trees. In the great majority of cases rifts are made in the bark and these rifts may extend over the whole length of the stem or may be restricted to a portion only. In the latter case the portion is usually, but not always, near the base of the stem The rift is occasionally continuous but is much more frequently discontinuous, the whole being composed of several separate rifts each of which is usually 5 to 20 feet long. The rifts are not merely cracks, the bark actually breaking away in a strip, more or less uniformly, 2" to 4" wide. It is unusual for rifts to appear simultaneously on two opposite sides of the trunk though this also sometimes happens They are usually so placed that their ends are separated by a few inches only measured along a horizontal line. The rifts invariably follow the direction of the longitudinal fibres in the bark so that a tree with left hand twist gives a left handed rift following the degree of twist, and the same for right hand twist. Where the bark has fallen off the cambium is found to be ruptured. I have never had an opportunity of examining a tree so recently struck that the cambium had not had time to partially dry, but a few days after being struck the cambium presents a shrivelled aspect wherever it is exposed, and frequently also dies back to some distance under the marginal bark so that a dead strip of cambium 3" to 6" wide eventually results.

Now with trees other than chir it is a common experience to find the whole or a portion of the stem deeply split or it may be completely shattered, but though I must have examined fully 100 chir trees struck by lightning I have never found one with even so much as a bough broken off and cracks of any size are most unusual. It is true that the natives of Garhwal will not use the timber of a tree which has been struck by lightning but this is due to superstition and not to any expected defect in the wood. On the contrary I have enquired of several contractors and have been assured that the timber is not effected by being struck, and I think this, as a general rule, is probably correct, though I have only verified the correctness of the statement myself in one case.

Lightning-struck trees may be found surrounded by others which show no signs of having been struck at all, and trees standing only 4′ away from a struck tree may thus escape. On the other hand several trees standing close together are usually all more or less similarly affected. Of a number of records which I have made of the maximum distance apart of any two trees struck in the same locality the four greatest distances are 50′, 36′, 35′ and 33′.

Young coir advance growth and small woody shrubs have been found killed within a circle up to 18 feet radius round the base of a lightning-struck tree, but it is more frequent to find such shrubby growth apparently unaffected and I have no record of herbaceous growth showing any signs of damage at all. It is of course well known that the taller an object is the more likely it is to be struck, and it would therefore be unnatural to expect to find shrubby growth affected to the same extent as trees standing overhead.

In a few cases I have found the tips of the branches of trees standing round a struck individual killed. In such cases the dead twigs, which appear as if they had been scorched, always face the struck tree, and though my observations are not quite complete in this respect I think the affected branchlets are never separated by more than a few feet from the branches of the struck tree. In other respects the trees whose twigs have been "scorched" show no signs of damage. This seems to me a very interesting phenomenon and one for which I can find no thoroughly satisfactory explanation. I should, however, like to offer two explanations in the hope that some one, after reading this article, will criticise my efforts and give the correct explanation. One theory I put forward is based on the assumption that the electrical discharge operates with power sufficient to kill outright any living tissue with which it comes in contact only over a very definite and limited area, and that outside this circumscribed area no effect is produced. Pursuing this theory I assume that the "scorched" twigs came within this circumscribed area whilst the rest of the tree remained outside and so escaped undamaged.

The horizontal position of the branch would tend to prevent the current from being carried down from the tip to the base of the bough and would thus assist in limiting the effect to the tips only. This circumscribed area theory is strengthened by the rather close agreement between my observations on the maximum distance apart at which trees show signs of being struck and the maximum diameter of a circle within which shrubs are killed; in both cases this is about 36′.

Another theory is that a current is induced between the surrounding trees and the tree actually struck, and that an electric current passes from the tips of some of the branches of these trees to the nearest branches of the struck tree in a more or less horizontal plane. To account by this theory for only the tips of the boughs being killed it is assumed that as the branch gets thinner the charge becomes more concentrated (if such a term is permissible) and a point is eventually reached at which the cambium is killed.

Trees when struck do not die at once and immediate visible damage seems to be limited to the death of a strip of cambium up to 6″ wide as already described. I have never seen the cambium show any unhealthy signs outside this strip. But if the actual damage were limited to this strip one would not expect a tree to succumb to such local injury when it is remembered what extensive injury of other kinds the chir can stand. As a matter of fact I believe that only a very small percentage indeed of trees struck would die if other agencies did not combine to complete their destruction. Overmature trees with decreasing vitality might succumb but not healthy sound trees in full vigour. From general observations which are not, however, based on definite countings, I believe that under existing conditions about 50 per cent. of trees struck (namely, so severely as to give clear external evidence) survive, and the death of the remaining 50 per cent. is, I believe, mainly brought about by insect and perhaps also fungal attack. On more than one occasion I have noticed how *Platypus biformis* and bark beetles may at once attack a struck tree commencing at first on either side of the rift in the bark and thence gradually extend their operations completely round the stem.

In a previous paragraph I had remarked on the way in which rifts appear in the bark parallel to the fibre, be it straight or twisted. It is interesting to speculate on the cause of these rifts, and my own opinion is that they must be due to the expansion of the woody tissue due to heat produced by the passage of the electric current. Subjected to a sudden thrust from inside the ring of bark would split wherever it happened to be weakest and the line of least resistance would of course follow the direction of the long fibres.

Another explanation which has been suggested to me is that the charge of electricity passes down the moist cambium layer but only along the line on which the rift appears and not in the cambium all round the trunk. In support of this theory it is argued that dry wood being a comparatively bad conductor, the current would keep to the better conducting material offered by the moist cambium, that the rift is caused by the sap being converted into steam, and that the fibres would, by offering resistance to a transverse current, cause the charge to follow their direction. This last assumption seems to me to lay too much stress on the resistance which would be offered to a current passing across the grain. Moreover if this explanation were correct it would be difficult to explain the discontinuous rift with the ends separated in a horizontal plane as explained above, and it would also be difficult to account for the way in which an oak tree may be completely smashed to pieces when struck, as happens, I believe, not infrequently in England.

However, these two theories are put forward with no other motive than that some one may be induced to point out their weak points and give the correct explanation.

From what I have written above it will be seen that I should account for the subsequent death of lightning-struck trees in the main to insect and fungal attack following on local injury caused to the cambium and I can find nothing to confirm any theory which would attribute subsequent deaths to the belated but direct effects of the lightning.

A. E. OSMASTON, I.F.S

THE BURMESE *ATHA* SYSTEM OF MEASURING TIMBER.

In the accounts for the extraction of timber for the Munitions Board, one of the vouchers showed payment to a contractor for a number of logs cubing so many *athas* and *soks* ; it was returned by the Deputy Controller as being beyond the powers of even the Accounts Department at Simla This system of measuring is used universally throughout Upper Burma yet there are but few people who understand it. Until recently the Forest Department collected duty on timber other than teak under the *Du* and *Yat* system, *i.e.*, so much per log according to its being 4' 6" and over or under 4' 6" in girth, irrespective of length. This has now been displaced by the tonnage system, but the local traders and the Mandalay brokers and saw-millers still stick to the 'atha' system for selling and buying. As will be seen from Mr. Cubitt's paper on the Jungle Wood Trade in Upper Burma, read before the Burma Forest Conference in 1910, all his remarks still hold true—the *atha* system is the main cause of wasteful logging of the tree in the jungle and for this and other reasons, the sooner it is abolished the better. Its disappearance will not begin in Mandalay but in the jungle where the local trader comes in contact with the Forest Department and in time the tonnage system will be forced on the Mandalay brokers. It has been the custom for a contractor getting a contract from Government., to hire the buffalo-men by the *atha* and get paid by the 'ton' and so, as will be shown further on, score heavily. But even now, the buffalo-man, as he begins to understand the tonnage system, much prefers it and in time will refuse to work under the *atha* system. At present when coming to an agreement with a contractor, the Forest Officer has often to persuade him that the rate offered, say Rs. 10 per ton, is just as good as the Rs. 12 per *atha* wanted by the contractor and he should therefore understand the *atha* system himself. It is a notoriously difficult thing to explain but the following may be helpful.

2 King Bodaw who reigned from 1781 to 1819 is said to have introduced the *atha* system but it is more likely that he merely

standardized the methods. The whole idea of it is a convenient way of measuring not the cubit contents of the log but the amount of converted timber that is likely to be got from it. Emphasis is laid on the word convenient because if the reader remembers that the *atha* system is a convenient method, and does not search for mathematical relations between girth and volume, he will understand the system much more easily. The small girth log has a larger percentage of loss in conversion than the large girth log and consequently more small logs go to the *atha* compared with their true volume than large logs. The one unit of measurement is the *daung* or cubit. Before King Bodaw's time there must have been a dispute over the length of the unit so he fixed it as the length of his own finger tip to elbow and measured it on an iron rod, marking the points with his own seal or 'Ziwaso.' The Ziwaso is the name of a bird. I do not know whether this iron bar still exists but the measuring rod now used is called the 'Ziwaso-daung." Not being quite certain of the history of this iron rod, I wrote* to the Superintendent, Archæological Survey, and he replied that the above account is slightly romantic and is not borne out by historical facts; nevertheless, the above is the common story given by the local Burmans and I can only hope that the Superintendent may yet find some historical basis for it. In Katha Division alone, there are three cubits in use, one for measuring teak logs which is 22 inches long, one for payment of felling and logging, which is 23 inches long, and one for payment to buffalo-men for extraction, which is 22½ inches long. This last varies the further from Mandalay, *e.g.*, in Bhamo it goes up to 24 inches. The varying cubit in the districts is called the jungle cubit to distinguish it from the fixed Mandalay one, the Ziwaso cubit. King Bodaw happened to be rather a tall man, so that his cubit taken as explained above measured exactly 19½ inches. There is no reason for this variation in the jungle cubit except that the further from the market the bigger the bargain wanted by the buyer. Once King Bodaw had fixed the cubit his people looking for an easy way of measuring it found that 16 rupee pieces placed in a line just covered the cubit. This measurement

by means of rupees is merely empirical and has nothing to do with the fixing of the length of the cubit. The cubit is now measured with a foot rule. The cubit is further divided into quarters or *soks*. A sketch is given below of the Ziwaso cubit stick used in Mandalay on a scale of about one-fifth actual size. The stick is usually made of 'Yindaik' (*Dalbergia cultrata*) and the gradations by brass pins.

3. For the measurement of length, no great accuracy is required. Logs had always been cut approximately 12 cubits long or 18 feet so King Bodaw fixed 12 cubits as the length of the standard log, which is the basis of his system. He then defined his standard or *atha* log as that measuring 12 cubits in length and whose semi-girth measured at 3 cubits from the drag hole is 2 cubits. The drag hole is always put at the root end of the log. One might well ask how he came to invent his definition, but King Bodaw was a practical man and he was after an easy way of measuring timber. From this point of view, halving the girth and measuring it by means of a short stick, the 'Ziwaso' cubit stick has its advantages, especially in the case of big girth logs. The standard log having thus been fixed, logs of varying sizes were expressed in terms of it. The method of doing so is most easily shown by means of tables: (*a*) Table I for logs of the fixed length of the standard log and of varying semi-girth and (*b*) Table II for reducing logs of varying length to standard length logs. Variation of both length and girth will necessitate the use of both tables.

Table I.

Logs of standard length and varying semi-girths.

Girth.					Volume					Amount payable per log at Rs. 20.					
Measured at 3 cubits from the "Napa."			Measured in middle of log		*Atha* volume factor.			Number of logs to standard *atha*.	Cubic contents Hoppus measurement.	Per *atha*.			Per ton.		
Semi-girth.			Mid-girth		"Agwesein"		In decimals								
Soks	Ft.	in.	Ft.	in.	Rs.	Mus.		Logs Athas.	C.ft.	Rs.	a.	p.	Rs.	a.	p.
1	2		3		4		5	6	7	8			9		
12	9	6	9	3	7	0	7·0	3 = 7	96·3	46	10	8	38	8	3
11½	9	1	8	10	6	5	6·5	3 = 6½	87·8	43	5	4	35	1	11
11	8	9	8	6	6	0	6·0	3 = 6	81·3	40	0	0	32	8	3
10½	8	4	8	1	5	5	5·5	3 = 5½	73·5	36	10	8	29	6	5
10	7	11	7	8	5	0	5·0	3 = 5	66·1	33	6	4	26	7	0
9½	7	6	7	3	4	5	4·5	3 = 4½	59·1	30	0	0	23	10	2
9	7	1	6	11	4	0	4·0	3 = 4	53·8	26	10	8	21	8	1
8½	6	9	6	7	3	5	3·5	3 = 3½	48·8	23	5	4	19	8	3
8	6	4	6	2	3	0	3·0	1 = 1	42·8	20	0	0	17	1	11
7½	5	11	5	9	2	5	2·5	1⅕ = 1	37·2	16	10	8	14	14	0
7	5	6	5	5	2	0	2·0	1½ = 1	33·0	13	5	4	13	3	2
6½	5	2	5	1	1	5	1·5	1 = 1	29·1	10	0	0	11	10	2
6	4	9	4	8	1	0	1·0	3 = 1	24·5	6	10	8	9	12	9
5½	4	4	4	3	0	7½	·75	4 = 1	20·3	5	0	0	8	1	11
5	3	11	3	10	0	6	·6	5 = 1	16·5	4	0	0	6	9	3
4½	3	7	3	6	0	5	·5	6 = 1	13·8	3	5	4	5	8	3
4	3	2	3	1	0	4	·4	7½ = 1	10·7	2	10	8	4	4	5
3½	2	10	2	10	0	3	·3	10 = 1	9·0	2	0	0	3	9	7
3	2	5	2	5	0	2½	·25	12 = 1	6·6	1	10	8	2	10	2
2	1	7	1	7	0	2	·2	15 = 1	2·8	1	5	4	1	1	11

N.B.—1. Column 2 has been calculated for a 19 in. cubit, *i.e.*, approximately the Mandalay *atha*.

2. Column 3 has been obtained from figures of IN trees measured for the Yinké Working Plan.

3. Column 4, a *mu* is a tenth of a rupee; this rupee has nothing to do with the present money rupee used in columns 8 and 9.

4. Columns 1, 4 and 6 are the only ones used in the *atha* system, the others have been introduced to show the comparison between the *atha* and quarter girth or Hoppus measurement.

5. Column 7 assumes a length of 18 feet.

TABLE II.

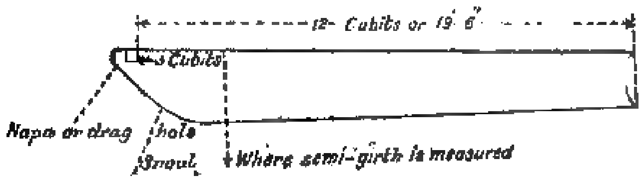
Logs of varying length reduced to standard lengths.

Length		
Cubits.	Feet.	
1	2	3
12	18	1 Standard length log.
15	22½	Semi-girth of standard length log increased by 1 *sok*.
20	30	2 Standard length logs.
25	37½	3 Do.
30	45	4½ Do
35	52½	6½ Do.
40	60	8 Do.
45	67½	9 Do.
50	75	10 Do.

In Burmese times logs under 18 feet in length were seldom extracted. Now that longer lengths of timber are wanted 18 feet is not the only length cut. Any log under 12 cubits is reduced by 1 *sok* in semi-girth just as logs of 15 cubits are increased by 1 *sok*. Any log measuring more than 11 cubits, *i.e.*, 11 times the 'Ziwaso' cubit, namely, 17′ 6″ is called 12 cubits and anything less than 15 cubits is also called 12. In practice for anything coming just under the 11 cubits, only ½ *sok* instead of one *sok* is deducted. In explanation of Table I, it will be noticed that semi girths are divided into half *sok* classes and that each class is given a volume factor (column 4.) The standard log, namely, the 8 *soks* gets a volume factor 3. Now there seems to be no reason why it should be given the factor 1 but probably Bodaw's reason was that with 1 as the factor, the smaller girth logs would have landed him into awkward fractions, while 3 gives convenient numbers for working with. For every half *sok* above 8 *soks* the volume factor rises by 5 *mus* or ·5 in decimals, though only up to 12 *soks* is shown in the table; *e.g.*, the 15 *sok* log would have a volume factor 10. Column 8 shows the rate that would be paid

for each semi-girth class at Rs. 20 per *atha*. This is got by ordinary multiplication of the factor (column 4) by the rate per *atha* and dividing by the volume factor of the standard log, namely, 3 in every case, *e.g.*, a $9\frac{1}{2}$ *sok* log would be paid $\frac{4.5 \times 20}{3} =$ Rs. 30.

In order to show more clearly how the measurements are taken a sketch of a log is given below :—



In measuring a log, the number of cubits from the edge of the drag hole to the end of the log is measured and noted. Then at a point 3 cubits from the edge of the drag hole, a cane is bound round the log. It is then cut and halved and measured with the 'Ziwaso' stick shown in para. 2 and the semi-girth given in *soks* and $\frac{1}{2}$ *soks*. Assume the logs measured have the following dimensions : —

No.	Length.	Semi-girth.
1	13 cubits	7 *soks*.
2	11 "	$9\frac{1}{2}$ "
3	17 "	6 "

For calculation rate of payment for No. 1 as 13 *soks* is the same as 12 *soks*, the length is that of the standard log, so that Table II is unnecessary. From column 4 of Table I, the volume factor for 7 *soks* is 2 : to find the volume, the volume factor must be divided by the volume factor of the standard log, namely, 3. If now the rate per *atha* were Rs. 30, the total paid for the log would be 2 multiplied by 30 and divided by 3 = Rs. 20.

Similarly for log No. 2, 11 cubits as per the Table II, has 1 *sok* deducted from its semi-girth. Though its semi-girth is $9\frac{1}{2}$ *soks* only $8\frac{1}{2}$ is taken and from column 4, the volume factor for

this is $3\frac{1}{2}$. The amount paid for the log at Rs. 30 per *atha* is therefore Rs. $\frac{30 \times 3\frac{1}{2}}{3}$ = Rs. 35.

For log No. 3, 17 cubits is from Table II the same as 15 and its volume is that of a 12 cubit log but of semi-girth increased by 1 *sok*, *i.e.*, to 7 *soks*. From column 4, the volume factor is $2\frac{1}{2}$ and amount paid at Rs. 30 per *atha* is Rs. $\frac{30 \times 2\frac{1}{2}}{3}$ = Rs. 25.

4. In practice when measuring a raft the value of each log is not calculated separately but a tally of the number of logs in each semi-girth class is taken. Logs of length other than the standard length are reduced to standard length under Table II and then entered as so many logs of their semi-girth class ; *e.g.*, a log measuring 30 cubits long and 6 *soks* semi-girth is at once entered as $4\frac{1}{2}$ standard length logs of 6 *soks* semi-girth in the tally. The measurement statement of a raft would then be shown in the following form :—

Semi-girth *sok*.	Number of logs.	Volume.	Factor *mus*	Total.	Volume factor *mus*.
		Rs.		Rs.	
16 ...	3	11		33	...
14	1	9	..	9	
12 ..	10	7	..	70	..
$11\frac{1}{2}$.	8	6	5	52	
11 .	16	6	...	96	..
$10\frac{1}{2}$.	21	5	5	115	5
10 .	20	5	...	100	..
$9\frac{1}{2}$ ...	5	4	5	22	5
7 ...	4	2	.	18	...
$5\frac{1}{2}$ ..	15	0=$7\frac{1}{2}$	.	11	$2\frac{1}{2}$
$3\frac{1}{2}$ ..	5	..	3	1	5
Total	108	..		528	$7\frac{1}{2}$

The number of *athas* in the raft is therefore dividing by 3, 176 *athas* and $7\frac{1}{2}$ *mus* left over; the amount paid for it at Rs. 18 per *atha* would be 176×18 plus $\frac{7\frac{1}{2} \times 18}{10 \times 3}$ = Rs. 3,172-8-0.

5. It is interesting to compare measurements under the *atha* system with those of the same logs in the quarter girth It is generally said that the Mandalay *atha* is practically the same as the ton, but it will be seen from Table I that the $8\frac{1}{2}$ *sok* log approximates more closely. Columns 8 and 9 of this table also show that large girth logs fetch a higher rate under the *atha* system than the ton but small girth logs very much less.

6. As the cubit increases according to the distance from Mandalay, the Bhamo *atha* log is a very much bigger log than the Mandalay one. In order to show the difference, the true volume by quarter girth measurement of each semi-girth class according as the cubit is taken as 19, 21 or 23 inches has been calculated and put in the following tabular form (the length is taken as 18 feet): –

Semi-girth at length *soks.*	Mid-girth.						Volume.			Number of logs to standard log
	Cubit 19"		Cubit 21"		Cubit 23"		Cubit 19"	Cubit 21"	Cubit 23"	Log *Atha*
1	2		3		4		5	6	7	8
	Ft.	in.	Ft.	in.	Ft.	in.	C. ft.	C. ft.	C. ft.	
12	9	3	10	2	11	2	96·3	116·3	140·2	3 = 7
$11\frac{1}{2}$	8	10	9	9	10	6	87·8	106·9	124·0	3 = $6\frac{1}{2}$
11	8	6	9	5	10	3	81·3	99·8	118·2	3 = 6
$10\frac{1}{2}$	8	1	8	11	9	10	73·5	89·4	108·8	3 = $5\frac{1}{2}$
10	7	8	8	6	9	4	66·1	81·3	98·0	3 = 5
$9\frac{1}{2}$	7	3	8	1	8	10	59·1	73·5	87·8	3 = $4\frac{1}{2}$
9	6	11	7	8	8	5	53·8	66·1	79·7	3 = 4
$8\frac{1}{2}$	6	7	7	2	7	11	48·8	57·8	70·5	3 = $3\frac{1}{2}$
8	6	2	6	10	7	5	42·8	52·5	61·9	1 = 1
$7\frac{1}{2}$	5	9	6	5	7	0	37·2	46·3	55·1	$1\frac{1}{4}$ = 1
7	5	5	6	0	6	7	33·0	40·5	48·8	$1\frac{1}{2}$ = 1
$6\frac{1}{2}$	5	1	5	7	6	1	29·1	35·1	41·6	2 = 1
6	4	8	5	2	5	7	24·5	30·0	35·1	3 = 1
$5\frac{1}{2}$	4	3	4	9	5	2	20·3	25·4	30·0	4 = 1
5	3	10	4	4	4	9	16·5	21·1	25·4	5 = 1
$4\frac{1}{2}$	3	6	3	11	4	3	13·8	17·3	21·1	6 = 1
4	3	1	3	5	3	9	10·7	13·1	15·8	$7\frac{1}{2}$ = 1
$3\frac{1}{2}$	2	10	3	0	3	3	9·0	10·1	11·9	10 = 1
3	2	5	2	8	2	10	6·6	8·0	9·0	12 = 1
$2\frac{1}{2}$	1	7	1	9	1	11	2·8	3·4	4·1	15 = 1

An 8 feet mid-girth log will measure 11 *soks* semi-girth at Mandalay, 10 *soks* at Katha and about 9 *soks* in Bhamo. If it were bought at Rs. 20 per *atha* at Bhamo the total cost price would be Rs. 26-10-8 and if sold at the same nominal rate, *i.e.*, Rs. 20 per *atha* at Mandalay it would fetch Rs 40. In all estimates of the cost of working timber to Mandalay this important variation should be considered

At present the ordinary *In* and *Kanyin* rafts being taken to Mandalay contain 168 logs averaging about 7 feet 6 in. mid-girth. Such a raft will contain many more *athas* than tons and therefore the sale price will be more per ton than per *atha* ; Rs 18 per *atha* will correspond approximately to Rs. 20 per ton. In the case of *Ingyin* where the average girth rules very much less, the rate per ton will be less than per *atha*, *e.g.*, Rs. 35 per *atha* will correspond to about Rs. 32 per ton.

A. W. MOODIE, I.F.S.

SIR WILLIAM SCHLICH, K.C.I.E., F.R.S.

Sir William Schlich retires from the professorship of Forestry at Oxford on the 1st January 1920, after a long career as a practical forester and teacher of forestry. Having served about twenty years in the Forest Department in India, the last few as Inspector-General of Forests to the Government of India, Sir William was deputed to start the teaching of scientific forestry in England in 1885. At that time scientific foresters were required in the Empire only for India and the opportunities offered by the then existing Indian Engineering College at Coopers' Hill were embraced and a forestry branch was added for the training of the recruits for the Indian Forest Service. Sir William remained as Professor of Forestry until the closing of that institution in 1905, and then moved over to the University of Oxford, where St John's College offered facilities and where a building was erected to house the Oxford School of Forestry. Sir William was first Reader and then Professor of Forestry, and now retires from active participation in the teaching of forestry. He has spent,

therefore, nearly fifty-five years in the practice and teaching of that science. To all who know him it will be obvious that so active a mind will not be content to lapse into idleness, and Sir William can still wield a persuasive and trenchant pen.

Decorated with the Companionship of the Order of the Indian Empire, Sir William was elevated to the Knighthood of that order in 1909.

It is no exaggeration to say that to Sir William Schlich, far more than to any one other man, the Empire owes the development of forestry within its limits. Heavy though his duties were when he started work at Coopers' Hill, Sir William found time to enquire into the condition of forestry in the British Isles and he prepared a report about thirty-two years ago in which he made recommendations for the management of the forests and forestable tracts of the United Kingdom and Ireland which, had they been adopted at the time, would have materially ameliorated the situation that faced the country in regard to timber supplies during the recent war. It is an open secret that the scheme now accepted for the developments of British woodlands is, to all intents and purposes, this scheme of thirty-two years ago.

In addition, Sir William prepared working plans for a number of woods, both state and private

The Indian Imperial Forest Service at this moment contains hardly half a dozen officers who have not been trained by Sir William Schlich, and there are students of his working throughout the Empire as well as in some foreign countries.

It would take far too much space to refer even briefly to all Sir William's achievements. His 'Manual of Forestry' is still the standard work in the English language, and in recognition of his scientific attainments he was made a Fellow of the Royal Society in 1906, the only Fellowship awarded for forestry.

Sir William has the satisfaction of seeing the organisation of forestry in Great Britain taken in hand before his retirement, and of knowing that the policy he urged for so long and did so much to foster is at last receiving due consideration.

On the date of his retirement the number of students undergoing the forestry course is greater than ever before, there being 103 students in residence So flourishing and popular, indeed, is the science of forestry that a students' association, 'The Oxford University Forest Society," was started in October last, with Sir William himself as its first Vice-President and he gave the inaugural address at the first meeting.

It will be remembered that, at the time of his retirement from the service of the Government of India in 1911, a presentation was made to Sir William Schlich by his former students Under the aegis of the above-mentioned society, a second presentation was made to him by the students in residence and a few past students of recent years on the occasion of his final lecture on the 2nd December. There was no time to address the past students who are abroad The presentation took the form of a handsome clock that had once been the property of Warren Hastings. In addition, a tortoise shell and silver trinket box was presented to Lady Schlich.

The Oxford University Forest Society held its first terminal dinner at the Randolph Hotel on the 4th December. This date happened to coincide with the visit of the Forest Commission to Oxford, and Lord Lovat, the Chairman of the Commission, and Mr. R. L. Robinson, a member, accepted invitations to be present. Sir William was the principal guest and besides having to reply to the speech proposing his own health he had, as Vice-President of the Society, to propose that of the Forest Commissioners, both of which speeches were delivered in his best manner. As there were about a dozen ladies (including six forestry students) present, Mr. Robinson performed the duty of proposing the toast to the ladies, Lady Schlich replying for the fair sex in a charmingly gracious little speech.

About eighty were present at the dinner, including the Professor of Forestry elect, Mr. R. S Troup, C.I.E., F.C.H., I.F.S., who was also a guest of the Society.

C. FISCHER.

REVIEWS AND EXTRACTS.

FOREST LIFE AND SPORT IN INDIA.

BY S. EARDLEY-WILMOT.

(Edward Arnold, London, Second Impression, 1911, pp. 324, 2 maps)

[Although the book reviewed was published some eight years ago we reproduce this review as it expresses useful ideas from America on the past and future development of Forest Conservancy in India.—HON. ED.]

No one who reads this authoritative book, from the pen of a former Inspector-General of Indian Forests, can be insensible to the charm of the forest life and sport from the Andamans to Kashmir. To one who has perhaps sickened of "desk-sergeant forestry" it is refreshing to learn that in a life service extending over thirty five years "some seven months of each year had been spent" (*in the field*) "in laying up stores of experience and local knowledge"; how many men of high rank in the United States Forest Service could say they had averaged even four months a year on field trips? The spirit and impression of Indian Service radiates from every page but what a pity the author could not have ventured at least a few chapters on the really technical and administrative problems that were current while he was Forestry Advisor to the Indian Government. But interspersed with the interesting accounts of shooting and tours there is much to interest the Forest Administrator who looks beyond the mere routine of red tape.

Few people think of India as extending from within eight degrees of the Equator to regions of perpetual snow, which occur at elevations of over 16,000 feet. For this reason and because of the importance of agriculture, which is usually dependent upon irrigation the preservation of a forest cover is essential to the economic future of the nation. And unfortunately most of the important rivers rise in regions that are *not* owned by the British Government.

It is clear that the future development of Indian forest wealth will be chiefly along two lines:

1. *Development of hydro-electric power.*—In a country where it is abundant and where fuel is scarce and extensive the lack of available capital for the development of this resource is unfortunate.

2 *Use of forests for paper pulp.* —Under present conditions most of the spruce and fir is used for fuel or timbers whereas its natural economic use is for paper.

Yet those who look to India for timber to ward off a world famine should not overlook the increasingly insistent demands of the local population. *Little will be available for export beyond teak and ornamental woods* aside from paper-pulp and tannin extracts. For, as Eardley-Wilmot points out, the objective of Indian forestry should be: ' to supply the requirements of its population in forest products, to protect the water-supply of the country, and to afford help in its industrial development." In the past perhaps too much stress has been laid upon the financial success of forest management and a happily phrased note of warning is sounded: "as in the case of European countries, the forest management should, as it always has, result in profit, but this profit should be subsidiary to the main objects in view... . ... The estimates of reliable and experienced experts are vain if it is insisted on that an increased revenue should precede an increased expenditure........... ..." A lack of sufficient appropriations for needed improvements thirty or forty years ago clearly resulted in the retardation of forest development and in the loss of efficiency of the personnel even where sickness and death did not result because of unsuitable quarters in a tropical country.

Perhaps the greatest task, which fell on the shoulders of Eardley-Wilmot as Inspector-General, was the betterment of the pay of the superior force, whose efficiency and integrity could be best secured by a salary commensurate with the social rank to be maintained. To reduce the salary below this point must be a danger point in colonial administration. "An eminent Viceroy once expressed horrified surprise that every public service in India

was pressing for better conditions of service, the mental shock might have been softened had he recalled Becky Sharp's remark that it is easy to be honest on 5,000 pounds a year."...... !

It is something to succeed in forest administration any where but think of the difficulty of succeeding with a tropical climate and the people of the Far East as permittees. Let's doff our hats to Eardley-Wilmot and his pals!

T. S. W. Jr.

SANDALWOOD.

[The following extract is taken from the Report of the Forest Department of Western Australia for the year ending 30th June 1919.—HON. ED.]

The year 1918-19 was the most valuable export year recorded, no less than £1,17,072 worth of sandalwood having been shipped. The next biggest year was 1882, when the export was valued at £96,050. The quantity shipped was, with the exception of 1882, the greatest since the inception of the industry. In that year the timber was worth £10 per ton, to-day it is worth £13. The wood was chiefly carried in Japanese ships of small tonnage. This industry has been purely a destructive one and the main profits have up to date found their way into the pockets of the Chinese merchants, who dispose of the wood in their own country. The distillation of sandalwood oil continues and approximately 3,720 lbs. were produced during the year under report. The gentleman engaged in this industry secured the services of an essential oil chemist, whose researches into the nature of this oil should be of great value. Up to the present the Western Australian oil has not been accepted by the "British Pharmacopœia." The content of the essential oil has now been brought up to the standard, but a further difficulty has been met with which would seem to require more research work. In the meantime it is finding a ready market in Australia and Java and has given every satisfaction.

A SCIENTIFIC PACKING BOX.

[The following abstract from the American publication "Barrel and Box" for May 1919 is reproduced not only on account of the interest which it may arouse in the minds of those who are connected with the manufacture and use of packing cases in India but as an example of the scope of the activities of a well equipped forest products laboratory, such as the U. S. A. have created at Madison. In another publication we have seen that the work of this laboratory in connection with packing cases alone resulted in a saving of twelve million dollars during the war. It is almost bewildering to think of the endless scope for similar investigation in India. The work of this department is rendered the more difficult by the rooted conservatism of the Indian people and the added difficulty of carrying on our propaganda in different languages and in such a manner as to reach both producers and consumers, many of whom are illiterate. India has clearly a lot to do and a long way to go before it is in a position to render similar services to those interested in packing case manufacture alone.—HON. ED.]

At a recent meeting at the Morrison Hotel, Chicago, of the Civic Industrial Committee of the Chicago Association of Commerce, a talk on packing boxes was given by C. P. Winslow, Director of the Forest Products Laboratory, Madison, Wis. He took as the theme for his address the subject of loss in the transportation of merchandise because of weak packing boxes. This loss has been placed at $10,000,000 a year in the United States and much of it would be saved if boxes were strong enough to carry the contents. Following is Mr. Winslow's explanation of the work which the laboratory is doing:—

MR. WINSLOW'S ADDRESS.

It is also very essential in order that our work really be successful that the results of it be effectively disseminated and put into the hands of those in a position to use it. During the War emergency of two years we were practically debarred from giving out any of the information on results of the work that we were on. It was contrary to the policy of the War Department to do so. Hence, I feel that a great deal of the work that we have been carrying on has not been made known to industry. In attempting to develop that phase of it we have arranged in co-operation with the Association of Commerce of Chicago to offer a short instructional course to representatives of the manufacturing and shipping interests of Chicago to be carried out at Madison

We are planning to start this course on the 28th of this month and carry it on for ten days. Our facilities are only extensive enough to permit us to handle 10 representatives at one time. We feel that what we can offer will really be of value to many of the concerns because of the experience we had in the past year in running similar courses for the officers and other representatives of the different army corps who were sent to our place for a period of from two weeks to thirty days and put through these courses in order that they could more effectively be used as inspectors and designers in the whole shipping containers' problems of the War Department.

As your chairman very clearly pointed out, the forest products laboratory is an organization of industrial research which is maintained by the United States Department of Agriculture at Madison. Therefore its activities are devoted to the services of the public. I like in a measure to look upon this gathering of citizens of Chicago citizens of the United States, in the nature of stockholders, which you are through your tax paying, in the nature of stockholders for whom our organization is working. The laboratory as a whole, is devoted in its work to the study of the properties and uses of wood and wood waste in all that that means. It covers in a broad way, strength, testing, kiln-drying, physical, mechanical and chemical properties of wood, going into the by-products of pulp and paper, wood distillation, alcohol products and so forth. Time does not permit that I go into any of those phases at this time.

During the war the forest products laboratory trained many inspectors of packing boxes, a continuous packing service school being conducted. During the past few weeks the laboratory has given a course of instruction to representatives sent by furniture manufacturers in the kiln-drying of wood and of glues, veneers, plywood, and built-up wood construction. In this way the information collected at the laboratory is placed in the hands of the manufacturers in a way in which they can utilise it. It is proposed, as I say, through the co-operation of the Chicago Association of Commerce, to give a similar course to representatives

of large concerns using many boxes and containers. The men who are to take this course of instruction are to be selected by the Chicago Association of Commerce. The number is limited to ten, to be selected one from each of ten companies. Instruction work will be conducted at Madison at the forest products laboratory, beginning Monday, April 28th, and will be continued for ten days. The laboratory makes no charge for this course of instruction. The course includes a study of the following subjects :—

SUBJECTS INCLUDED IN INSTRUCTION WORK

1. *Nailing.* Commercial packages are frequently insufficiently nailed. Laboratory data is available as to many details in regard to the proper nailing, including size and types of nails to be used.

2. *Screws and strapping.*—With the testing machine the strength of strapping can be demonstrated. Data show the injurious effect of driving screws.

3. *Thickness of Material.*—Demonstration of principles of balanced box construction. Increasing thickness of material alone does not necessarily afford additional strength.

4. *Cleats.*—Greater reliability of cleated over uncleated boxes.

5 *Effect of contents on Serviceability of Packages.*—Tests show that often times character of contents influences the type of construction

6. *Methods of Packing.*—Packing as well as container design affects the amount of shipping space and the durability of the package.

7 *Species.*—Laboratory data on strengths of various species allows grouping of woods according to values for box manufacture Tests indicate that thickness of material should depend on species used.

8. *Crating.*—Data is available on comparative size of members, types of corners on joints, sizes of nails and bolts.

9. Supplementary data available on associated problems such as drying of wood, wood structure, glues, methods of wood identification, etc.

Equipment is two hexagonal drum testing machines with the larger capable of taking containers up to 4 feet in length and 800 pounds in weight; apparatus for drop tests; numerous small machines for nail pulling and static tests; other equipment necessary for box construction and demonstration purposes.

A motion picture reel showing the method of testing, improving and designing shipping containers was shown. A box was shown under construction and after loading with material of approximately the same weight and character as that used in service it was tested by means of a drop test. A box similar in type, but more economically designed, was then tested and equal strength was shown with a saving of 15 per cent. in shipping space. The boxes were juggled in a revolving drum or tumbling machine 14 feet in diameter revolving at one revolution per minute. This test simulates conditions of actual service and is really an accelerated service test.

The effect of using a different number of nails on each nailing edge was shown. The effect of the accelerated service test on a crated gasoline engine weighing about 800 pounds was also shown. Various compression tests which demonstrated the relative rigidity or weaving resistance and simulated service conditions in large piles of goods were made. A cornerwise compression test demonstrated the advantage of proper end construction and the value of cleats. The resistance of nails to withdrawal is measured in a testing machine and the various details of box construction were separately tested.

In addition to the moving picture illustrating the testing and improving of boxes, another picture was shown which gave in detail many of the various activities of the forest products laboratory in its industrial researches in new uses for wood.

ROSIN NEEDS OF AUSTRALIA TO BE MET RUN INTO THOUSANDS OF BARRELS.

[FOR FIRST FIVE MONTHS OF SEASON CONSUMERS THERE SECURED VERY LITTLE FRESH SUPPLIES.]

If Australia and New Zealand are not abandoning the use of rosins this season there are considerable vacuums there to be filled in the next six months. There is no reason to believe that much

rosins was carried over from last season, and as there has been for years a fairly uniform demand for the commodity in those countries it would naturally seem that this season should be little or no exception to the rule. While business reports from them are somewhat meagre as compared to the information as to European conditions there is seemingly no reason why Australia and New Zealand should be in a depressed state as to the industries using rosins. To the contrary, one would expect them to be situated somewhat like the United States, with large unsupplied demands to be met and industries generally working hard to meet them.

For the first five months of the current season April August Australia and New Zealand imported the beggarly amount of 2,465 round barrels of rosin, the smallest on record for an indefinite number of years. For the same months last season the imports were 13,399 barrels. For all of last season the imports were 21,810 barrels. For purposes of comparison it may be well to go back to the war period. For five years then the average imports were approximately 23,000 barrels annually. This leaves Australia and New Zealand up to September, nearly 20,000 barrels short of an average yearly peace time importations of rosins. As a matter of interest we give below the importations of the two countries for a term of years :—

Season	Round Bbls. Rosin.
1918-19	21,810
1917-18	42,052
1916-17	17,098
1915-16	20,860
1914-15	11,546
1913-14	32,758
1912-13	22,004
1911-12	26,360
1910-11	18,870
1909-10	14,113

(*Naval Stores Review, 18th October 1919.*)

THE PUNJAB FOREST SCHOOL.

The final examinations of the Punjab Forest School were held as usual in Rawalpindi East Division, from 1st to 9th December 1919. The Board of Examiners consisted of Mr. W Mayes, Conservator of Forests, Western Circle, Punjab, Mian Budhi Singh, Divisional Forest Officer, Rawalpindi East Division, and the writer. All the 12 students composing the class succeeded in getting certificates. They did fairly well in practical sylviculture and 4 students obtained over 75 per cent. marks in the aggregate. The results were announced and certificates were distributed by the President of the Board of Examiners at Kahuta on the morning of the 10th December 1919. The following prizes were very kindly handed over by Mrs. Mayes to the happy recipients :—

1. The best student's prize, offered by the President, was awarded to Amir Chand, Deputy Ranger.
2. First prize in practical Forestry, offered by Mian Budhi Singh, was awarded to Ram Saran, Forester, Baghat State, Simla District.
3. First prize in plane-table survey, offered by Dewan Mahesh Das Tahsildar, Kahuta, was won by Hari Singh, Head Guard.

Mian Budhi Singh then in a clear and well-considered speech, appreciatory of the results of the class, dwelt on the usefulness of the institution and spoke on the Instructor's work done by him during the last six years. He advised the out-going students always to bear in mind that their own future and the good name of the Forest School were in their keeping, and that by honest and strenuous work they should try to win the approbation of their officers and should be always loyal to their Sovereign and the benign British Government.

Mr. Mayes then expressed his entire satisfaction with the results of the examination and congratulated the Instructor on the work done by him during the last six years.

The whole party was photographed in the evening and thus brought the function to a close.

JHELUM :
20th December 1919.

PREM NATH, P.F.S.,
Instructor, Punjab Forest School.

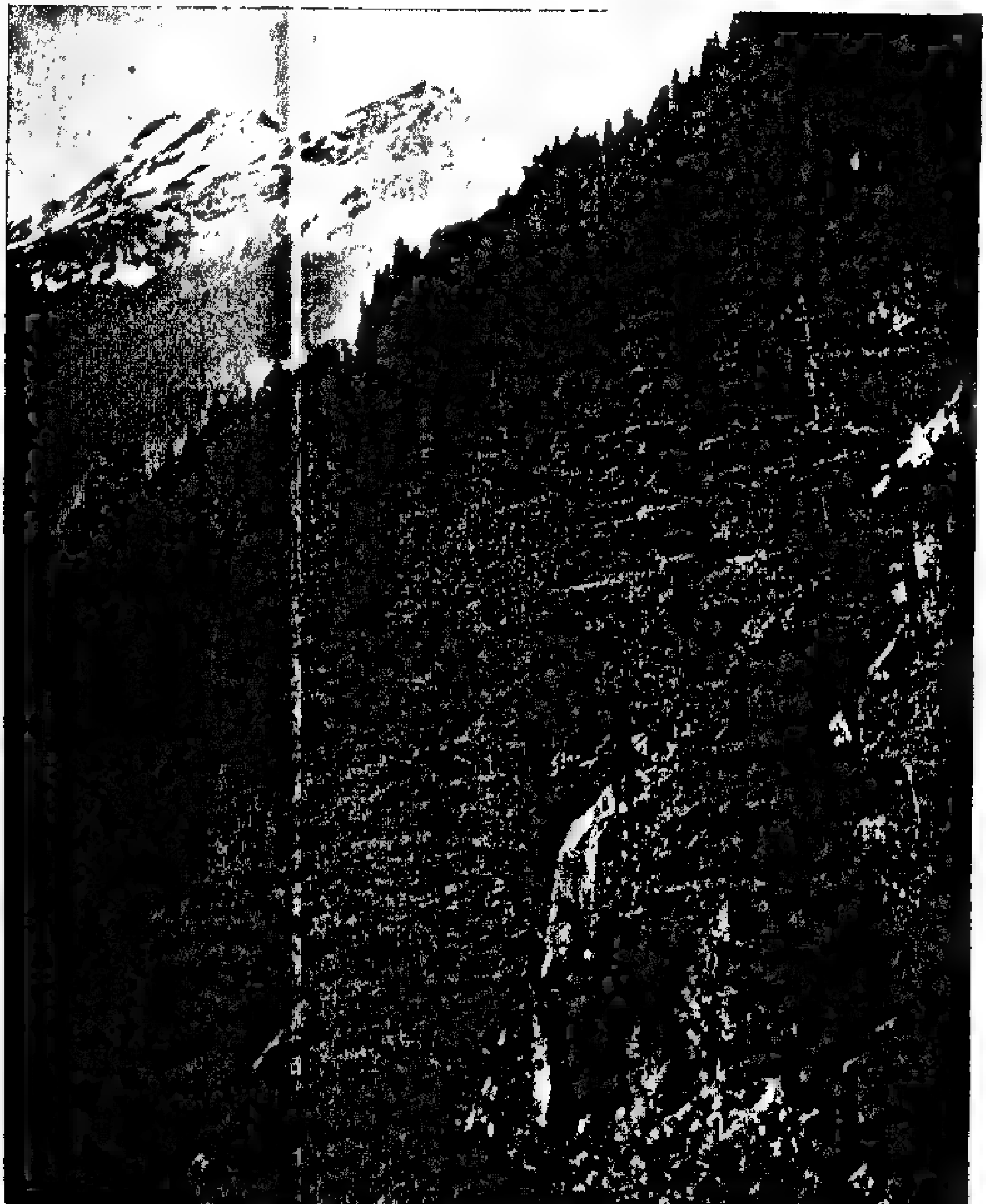


Fig. 1. A deodar forest in the Upper Sutlej Valley.

[Frontispiece.

VOLUME XLVI NUMBER 4

INDIAN FORESTER

APRIL 1920.

LUMBERING IN THE UPPER SUTLEJ VALLEY (PUNJAB).

PART II.—SCANTLINGS.

Part I dealt with logging operations which had been restarted by Government after having been abandoned for many years throughout the Punjab. Logs take so long to reach the Sales Depôts that traders were unable to stand the interest charges and were unable to incur the heavy expenditure on logging roads.

The Sutlej Forest Company commenced work in 1907 and extracted the annual yield of the Bashahr Division in the form of scantlings which consisted mainly of deodar railway sleepers. Blue pine and chir were worked on a small scale while the sale prices of silver fir and spruce were too low to pay for the cost of extraction. The Company's working at one time reached a high standard, and the introduction of Mr C. H. Donald's patent light ropeways for the carriage of scantlings facilitated transport works in the very precipitous forests of Upper Bashahr, and indeed throughout the Himalayas.

In September 1917 when departmental timber operations were resumed, the demand for timber by the Indian Munitions Board both for overseas and for use in India was greater than the whole pre-war yield of the Punjab and prices of inferior coniferous timbers rose rapidly.

In order to form a reserve by means of which the timber market could be controlled and the rising prices demanded by timber traders checked, the Board asked for the Bashahr Division to supply thirty thousand tons of coniferous timber by March 1920.

When the war stopped this order was cancelled and the rate of extraction was somewhat reduced. There is, however, such a shortage of railway sleepers owing to the cessation of imports during the war and to their export to various war fronts that it has become necessary to divert the labour to the extraction of railway sleepers.

The supply of deodar has never been equal to the demand, and as the large stocks of over-mature deodar timber formerly found in the forests have been nearly exhausted, it is certain that for the next twenty years the supply of deodar timber will not be equal to that demand. Consequently the North-Western Railway has commenced to build modern plants for creosoting chir, silver fir, and spruce timber and the greater portion of the expected yield of these species has been allotted to the Railway.

In addition to railway requirements the demand for all coniferous timber by the general public is so great as to necessitate the continuation of lumbering works on a scale which primarily had been designed for war conditions.

Machinery was quite unobtainable during the war and, as the mines had the first claim to all wire rope, ropeways could not be obtained. Even now although rights were secured from the patentee in 1917 and wire ropes were ordered months ago none have as yet arrived in India.

The current operations will now be described.

Trees are felled by the axe as described under logs.

Fig. 2. Squaring Logs.

Fig. 3. Sawing.

Sawing is done by hand with a frame saw, sawyers work in pairs and a mistri squares the logs with a heavy axe as shown in the photograph.

Sawing.

The greatest trouble has been experienced in finding a sufficient number of expert sawyers as skilled workmen are much in demand. Practically the whole of the labour has to be imported from a distance, and when Government first commenced work in September 1917 the whole of the available good labour was already employed on traders' works.

An iniquitous system of advances has gradually sprung up until nowadays it is necessary to give out an average amount of Rs. 150 per pair of sawyers in order to ensure obtaining the best pairs. Competition for sawyers is keen and unscrupulous agents of some Sudh traders in Simla have no hesitation in stealing labourers from other traders or from Government. The Bashahr Forest Division is in one of twenty-seven Native States in the Simla district and borders on the United Provinces on one side and on Punjab British territory on the other. Sawyers sometimes take advances from three or four traders in as many different States as well as from Government and have to be hunted down through a number of different States in each of which a fresh endorsement on the warrant has to be obtained before they can be arrested. Sawing contractors exist only in name, and as Government had none in 1917 and had to work at full speed from the beginning the risk of losing advances made to men of poor financial stability had to be taken. No money advanced has as yet been definitely lost and it is thought that an allowance of one per cent. on the total lumbering expenditure will be sufficient to cover this risk, or less than one pice per cubic foot of outturn, a smaller risk than would willingly be taken by any business firm.

Contractors' accounts with their sawyers have to be regularly audited and standardized, and the greatest trouble is experienced in seeing that the so-called contractors and sawyers do not cheat one another. Trouble taken is, however, amply repaid and it really appears at present as if the sawyers were beginning to appreciate the care taken by the department to see that they are

not cheated. As few, if any, contractors possess sufficient property to cover the amount of money advanced to them it is evident that the poor Divisional Forest Officer has at times had much to worry him. In spite, however, of the great difficulty of obtaining labour, some four lakhs of scantlings have been sawn up to the middle of December 1919.

Land transport.

Scantlings are carried on coolies' backs to the launching points except when dry slides can be used which is only on easy ground, the use of dry slides on steeper ground being inadvisable as the scantlings get up such speed that they are smashed on jumping from the slide. The construction of dry slides, which are used mainly for heavy beams up to 16 feet in length, is simple, consisting of a beam and a karri flanked by beams on each side morticed into cross-ties or simply pegged to the ground as illustrated in the photograph. Slides are in broken lengths of a few hundred yards each and lead to earthen holes in which the beams are brought to rest often after obtaining a speed of twenty-five to thirty miles per hour.

Light portable wire ropeways, such as those patented by Mr. Donald and described in the *Indian Forester* in 1916, are badly needed and have been ordered from England as the carriage of sleepers on coolies' backs is a very slow process especially in precipitous ground. The amount of carriage labour is seldom sufficient and certainly not sufficient to ensure the rapid clearance of forests in time to take advantage of the most favourable floating season.

Water transport.

The precipitous nature of the country and the great heights above the Sutlej river to which the mountains rise cause the beds of streams to be very steep and to contain numerous falls.

In Lower Bashahr these streams are similar to and but little worse than those in the outer Himalayas, floating being comparatively easy.

In Upper Bashahr, however, the nullahs are subject to sudden floods, contain numerous cataracts and are certainly the most

Fig 4. A dry slide.

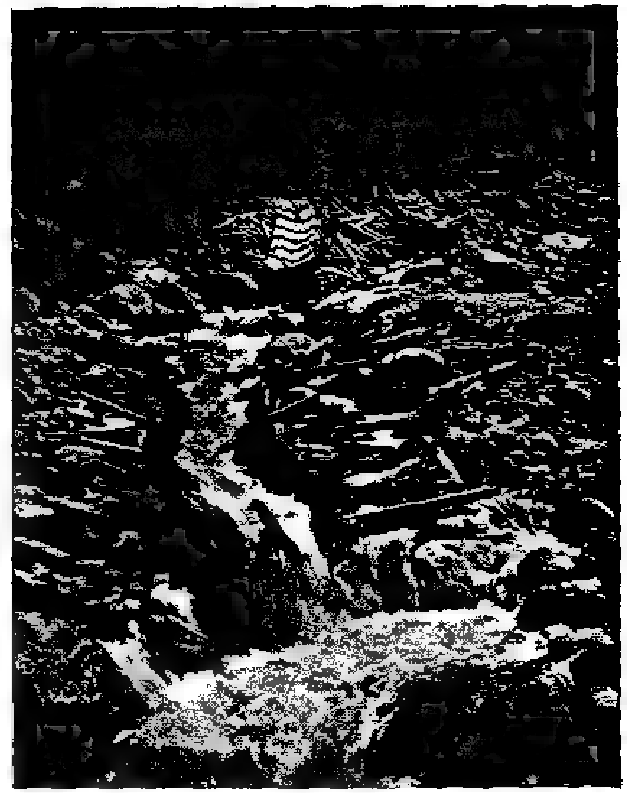


Fig. 5. Telescopic floating.

difficult to work of any streams in the Himalayas. Local men will not face the dangers of these torrents and highly skilled floating labour and slide carpenters have to be imported.

Under the skilled management of Mr. Donald, late Manager of the Sutlej Forest Company, a great improvement in floating methods took place and streams which had previously been considered impossible were negotiated successfully.

Floating work is always dangerous and accounts for nearly as many deaths as felling from accidents which cannot be avoided however many precautions are taken.

Telescopic floating.

Telescopic floating is the form most used and when water is sufficient falls of considerable height can be negotiated without much damage to the scantlings, a platform of scantlings being built up over which a semi-water-tight slide passes leading into an artificially formed pool of water in which the impetus of the fall is broken.

In 1918, 27,000 scantlings were passed in this manner over a hundred foot fall while in another nullah, where at one place the falls are two hundred and fifty feet high, the stream was diverted through a pakka slide along the face of a precipice above the cataracts and a succession of artificial pools were formed down the hillside into which the scantlings entered from telescopic slides.

Wet slides.

Pakka wet slides are used when the streams are too bad for telescopic floating. They are of the usual pattern consisting of a water-tight channel on raised supports floored by a sleeper and a karri with sleepers for the sides, securely morticed into cross-pieces and the joins made water-tight with moss. Professional carpenters and slide coolies are imported for their construction.

The slide shown in the photograph of the Raturing gorge was constructed in 1919; it proved very efficient and carried over 30,000 scantlings successfully, whilst the Range officer reported that as many as 1,500 scantlings travelled down it in one hour.

River floating.

The Sutlej river offers peculiar difficulties in floating scantlings; in winter numerous rocks appear in the bed of the Upper Sutlej and the

river occasionally disappears below the rocks. In the Katholu gorge at the end of September 1919, there was still sufficient water for sleepers to pass without much difficulty; later on the water passes entirely below the rocks and a man can cross the river dryshod.

As Katholu is only the worst of many similar gorges it can easily be imagined that floating is not only difficult but very expensive and that breakage is common once the water has fallen sufficiently to uncover the rocks.

From April 15th onwards the Sutlej is ordinarily in flood, the speed of the river being such that scantlings cannot be caught at the catching depôts and are likely to be swept far down the river and lost. During August and part of September the rocks are covered and once the river has fallen sufficiently, usually about August 15th, scantlings are launched rapidly and strand in the lower river in numbers where they are salved and afterwards taken down with the scantling ghalls in October If scantlings have not got past Katholu by the middle of October they are taken out of the river and stacked to await the next year's floating season.

Catching depôts

At the catching depôts, situated where the Sutlej debouches from the hills, a boom is maintained during the cold weather consisting of sleepers and bamboos wired together and anchored by steel cables, a rather primitive arrangement which will shortly be replaced by a boom of the Dhakh Pattar (United Provinces) pattern.

Rafting.

Sleepers are tied into rafts at the catching depôts and from there to the Sales Depôts work is easy and in marked contrast to work in the higher hills, the Sutlej broadening out considerably and finally entering the Sirhind Canal down which rafts are leisurely navigated by yet another set of men engaged locally.

Food supplies.

From what has been written above it has been seen that by far the greater part of the labour is imported. As cultivation is scarce and not even

sufficient for the local population all food for foreign labour and for part also of the local labour engaged in scantling work has to be imported.

Purchases are made in the plains and in the lower hills and food-stuffs are transported in many miscellaneous ways along paths which degenerate from the *Hindustan-Tibet Road* and main forest bridle-paths, suitable for mule traffic, to tracks along which only sheep and goats can pass. Food is sold at cheap rates to workmen, and an idea of the extent of the purchases and transport involved can be formed from the fact that the Budget expenditure of the Provincial Service Officer in charge of the Godowns averages two and a quarter lakhs of rupees per annum, while no less than twelve hundred bullocks are maintained for the season on one route alone.

Mechanical apparatus.

The difficulty of procuring labour and of feeding the labourers and the high advances demanded by sawyers render it imperative to supplement the local methods of conversion and transport by mechanical means. As already noted ropeways admirably suited for the carriage of sleepers and beams in precipitous ground have been ordered from England. Even if the direct savings are small the use of ropeways will be justified in the saving of food-stuffs and in the greater certainty of transport.

Owing to the precipitous nature of the country and its remoteness from the plains it is doubtful if much progress in logging machinery can be expected, owing to the heavy capital cost, high working expenses and great weight of logging ropeways.

Sawing machinery offers some difficulty as although for years past attempts have been made to procure light portable saw-mills no suitable pattern has as yet been found.

Except in the virgin spruce and silver fir forests it is more than doubtful if saw-mills can be used profitably owing to the scattered nature of the deodar, kail and chir forests. The virgin fir forests, however, offer favourable conditions for working by saw-mills inasmuch as they form compact blocks of mature high

forests from which logs can be brought by slides to one or more centres in each forest at which mills can be erected.

Ample water-power is available in or near the fir forests and a site for an hydro-electric plant has been chosen by the Chief Electrical Adviser to Government who has estimated that with a gross capital expenditure of Rs. 17,000 45 brake horse-power can be delivered at the saw-mill itself. Logs sufficient to yield some lakhs of sleepers can be delivered at not more than three separate sites in the forest, and it is believed that the Punjab Government will sanction the capital outlay necessary for an experimental plant sufficient for conversion on a large scale. If this plant proves successful it is unquestionable that saw-mills will in future perform a great part of the work of conversion in fir forests throughout the Himalayas.

Hand operations will undoubtedly continue to form the backbone of our work in the Himalayas, but with the formation of an engineering branch of the department it is expected that lumbering methods will be improved and that departmental timber exploitation will prove even more profitable than at present.

To deliver a railway sleeper in the plains costs from Rs. 2 to Rs. 2-4-0, calculated roughly as follows :—

	Rs.	a.	p.	
Felling	0	0	3	per B. G. sleeper
Sawing	0	8	0	
Carriage	0	8	0	
Floating	0	8	0	
Rafting	0	2	9	
Loss in godown	0	2	0	
Establishment	0	1	0	
Losses and breakage ...	0	2	0	
Total ...	2	0	0	

or about ten annas per cubic foot, being slightly higher in the case of fir and lower in the case of chir timber.

The selling rates are roughly as follows, but are on the increase :—

	Deodar			Kail.			Chir			Silver fir and spruce.		
	Rs.	a.	p.	Rs.	a.	p.	Rs.	a.	p.	Rs.	a.	p.
Beam sizes per cubic foot ..	2	8	0	1	8	0	1	8	0	1	4	0
							to					
							2	0	0			
B. G. sleepers supplied under contract to the North Western Railway	5	0	0	..			2	13	0	2	8	0
B. G. sleepers sold in the open market.	5	8	0	5	0	0	4	0	0	3	4	0

All these rates are rising and except in the case of spruce and silver fir are ample for a considerable margin of profit, although it is too soon to make a proper forecast owing to the large stocks of timber still in transit.

With the formation of a Utilization Circle in the Punjab the marketing of this timber will be immensely improved and there is little doubt that the above prices will be surpassed in the near future

The cubic foot royalty offered by companies for standing trees purchased in Upper Bashahr has never exceeded 6 annas in the case of deodar, 3 annas in the case of blue pine, 2 annas in the case of chir and practically *nil* in the case of spruce and silver fir timber ; consequently it is expected that in a tract of country so remote and difficult to work as Bashahr the profits realized from departmental timber working will far exceed those realized from leases

H. M. GLOVER, I.F.S.

16th December 1919.

FORESTRY WITH THE B. E. F.

BY J. D. MAITLAND-KIRWAN, I.F.S.

As I spent nearly twenty months with the Forestry Corps which formed part of the British Expeditionary Force in France the Editor has asked me to write an account of my experiences while serving in it. I have told him that as I have practically no notes on the subject any account I give must be to a large extent non-technical and in a lighter vein than the usual run of articles in the *Indian Forester*, but he tells me the lighter the better. I will therefore do my best on those lines, leaving the Editor to blue pencil anything which he does not consider of sufficient interest.

I will in this first article explain the events which led up to my obtaining an appointment in the Forestry Corps.

I left Bombay at the end of March 1917 by the ill-fated Medina on seven months' hard earned leave. I landed at Marseilles and the ship was torpedoed in the Channel after calling at Plymouth, all the heavy kit of course being lost, and mine unfortunately being uninsured. I had only been a short time at home when I felt that I certainly ought to join the army if I could obtain permission to do so. I accordingly approached the India Office on the matter, and they in turn communicated with the Government of India, the result being that eventually I was given permission to join the army for the duration of the war.

I had very little idea as to how to get a commission, but was told that the best thing was to go to the War Office and ask for an interview with some one. This I did, and thus gained some acquaintance with what is, I suppose, the biggest red tape factory in the world. We all have some experience of red-tape in Government service in India, but compared with the military article civilian tape is of the palest shade of pink. The need of officers was at this time very great, and one would therefore have imagined that suitable applicants for commissions would have been welcomed. If this was the case the officials concerned had a curious manner of showing their feelings, and so curt and unhelpful was the young officer who interviewed me that I eventually

found myself wandering about the streets looking at recruiting placards for the Navy, and wondering if I could get a commission in any branch of that Service. One man told me that a friend of his had tried to get a commission in the army, but was so curtly treated at the War Office that he went across to the Admiralty, where he was courteously received and at once put in the way of a job. "Go to the Admiralty," I was advised, "they will treat you like a gentleman there." However it appeared that owing to my age I should only be able to get a shore job in the Navy, so next day I returned to the War Office, and through some understrapper managed to get and fill up some application forms, and then went off to be medically examined.

I was told to go to such and such a hospital, and it all seemed to be plain sailing. On my arrival, however, I was told that the Medical Board was not there at all but at some other hospital in another part of London. I dashed off there and after wandering through various passages I found an official whom I asked to show me where the Board was sitting. He told me that it had moved some weeks ago to another hospital, so off I started again in hot pursuit, and finally ran it to earth. I found, however, that I had arrived too late and that I must come again next morning. Next morning accordingly I put in an appearance, and found a number of other aspirants to military glory sitting in a room looking uncomfortably at each other, and awaiting medical examination. After an interminable wait (I soon discovered that little can be accomplished in the army without waiting about for a long time first) an official came in and examined our papers (one always has to have "papers" in the army), and of course discovered that mine and those of one of the other men were not in order. It seems that although we had brought some filled in forms with us these were not sufficient, and we therefore received instructions to return to the War Office at once and ask for another one (nothing can be done in the army without first filling up countless forms). Having with difficulty obtained this form I just managed to struggle back in time to be examined before the Doctor shut up shop for the day. He passed me as category A, but said that he

advised me to go into the Artillery rather than the Infantry, at which I was quite pleased. Years before I had served a stirring apprenticeship as an infantryman at Coopers Hill in the ranks of the gallant Berkshire Volunteers, and more recently I had had some success as a cavalryman in that famous regiment, the United Provinces Light Horse (I was promoted sergeant as my horse kicked so badly that they would not have it in the ranks). Having therefore had some experience of these two arms of the service, and intensely disliking them both, I was quite ready to follow the Doctor's advice and to try my luck in the Royal Regiment of Artillery.

I returned to the War Office, and after filling up another form and being interviewed again I was told that I would be sent to a R. F. A. Officers' Cadet School. The Officer who took charge of this form asked me if I would like some leave before joining up, and said that he could arrange to give me as much as I wanted. I thought this a good proposition and replied that I would like a month, and he therefore noted on my papers that I was not to be called up before a certain date about a month later. I therefore settled down to enjoy my last month of freedom. Alas, I did not at that time know anything of the ways of the army. Within a few days I got a letter from the War Office telling me that I was posted to the R. F. A. Cadet School at St. John's Wood, London, and that I was to report there immediately.

Now to a civilian mind the obvious thing would have been to go and report oneself at the Cadet School, but in the army one never does the obvious thing; it would, I suppose, be bad strategy. I was directed to go to the nearest recruiting office and enlist in the army, which seemed simple enough. Being at Eastbourne at the time I went to the recruiting office there, and imagined that the ceremony would take a few minutes at the most. My education in army methods was, however, only just beginning. I was told to go away and call again, and finally I was kept waiting about for the best part of two days. At the end of that time the office decided that they could not recruit me at all, and that I must go to Chichester and enlist in the Royal Sussex Regiment.

It was in vain that I pointed out that my papers told me to enlist at the nearest recruiting office and then proceed to the Cadet School, and to Chichester I had to go, and was technically made a private in the Royal Sussex. The reason for this seemed to be that if I got the sack from the Cadet School I should belong to some unit to which I could be returned, but it seemed to me a cumbrous procedure.

I had to be medically examined at Eastbourne previous to enlisting. As I had already been examined in London and passed A one would have imagined that to be sufficient, but, as I say, things in the army are different. I always wonder what would have happened if the Eastbourne people had put me in category B, in which case I could not have gone to the R. F. A. Cadet School, where, however, I was going on the strength of having been passed A by the London Doctor and in accordance with his specific advice. As a matter of fact I had great difficulty in getting passed A at Eastbourne. The R. A. M. C. Officer who examined me was an elderly gentleman of the irascible comic paper type, and he was emphatic that I would not stand the R. F. A. work, and was only induced to pass me when his subaltern assured him that all a Gunner Officer had to do was to shout "Fire" through a megaphone.

I duly reported myself at St. John's Wood barracks, and found a number of victims waiting about for something to happen. I joined them and helped them to wait about for an hour or two, at the end of which we were put into a shed and ordered to don the King's uniform, the ordinary gunner's unform, but with a white band round the cap as the mark of a cadet. On arrival at the barracks I had found that, in accordance with the army system, the reason why we had been told to report there was that the first part of our training was not to be there at all but at the Handel Street barracks, a very gloomy place in the neighbourhood of St. Pancras. Why on earth we should not have reported and been fitted out there passes comprehension, but so do many things in the army. When therefore we emerged from the shed a bedraggled looking crew clad in ill-fitting garments, we were

herded through the streets and by way of the underground railway to what was to be the scene of our tortures during the coming month As I marched along carrying a particularly heavy kit bag containing all the spare kit I had just been given, with my civilian clothes and best London hat squashed in on the top of them, the fires of my patriotism, I must confess, burnt somewhat low.

It is not my intention to give a detailed account of life in a Cadet School, as I must remember that I am supposed to be writing on Forestry; a few sidelights on a cadet's life may not, however, be without interest to those who know little about Cadet Schools, institutions which played such a large part in training our officers during the war.

The School to which I was posted, and it was I expect typical of all, contained three classes of men, firstly those who had fought in some theatre of war and had been recommended for a commission, secondly residents at home who were trying for a commission and who, by the rules then in force, had been compelled to undergo a short course of training in the ranks first, and thirdly those, like myself, who had come from overseas, and who were therefore given the privilege of going straight to a Cadet School without first serving in the ranks. At Handel Street and St. John's Wood the first class predominated, and the course was to them, if not exactly child's play, at least very much easier than it was to the other two classes, as they were already experienced soldiers and many of them had actually served in the Gunners and knew all the drill, etc. The second class had a great advantage over the third in having already had about two months' training, whereas we who came from overseas had everything to learn; there were only a handful of us, and we found the course a painful experience which we should not care to repeat. However we had our lighter moments, and I remember frequently saying that when in after years we recalled our suffering we should have plenty to laugh over, and should feel very glad of having gone through the experience; I can truthfully reiterate this to-day.

We had to spend a month at Handel Street and then all those of us who had succeeded in passing the necessary exams. went either to St. John's Wood (and this was my fate) or to a School established on Lord's cricket ground, where about three months were spent, and this was followed by a practical course on Salisbury Plain or at Shoeburyness. The month at Handel Street was supposed to "smarten us up," and it certainly did. I soon discovered that there were other things to learn besides shouting "Fire" through a megaphone. One of these, a process known as "cleaning up," dogged us with fatal persistency through every hour of the day. A cadet was compelled to appear on every parade with his cap badge, buttons, spurs, and boots shining to such an extent that one would have imagined that no man of ordinary vision could have looked at them except through smoked glasses; his lanyard and cap band had also to be of spotless white. As there were parades all day from dawn to dusk it followed that every spare minute had to be spent in cleaning up.

I well remember our first morning parade at Handel Street. We had spent a considerable portion of the previous night polishing everything we could think of so as to create a good impression at our first inspection. We trembled as the Major walked down our ranks and scanned each one of us from top to toe with an intensity which amounted almost to impertinence. Did we receive our meed of praise for our conscientious endeavours? No, we did not. The Major was a taciturn man and, in a tone of withering contempt, he uttered four words only "Disgusting, buttons not touched" They never encourge you in the army; it might lead to some one getting swelled head.

I could write reams on the subject of cleaning up, and on the dire results ensuing on the failure to be properly cleaned up; I could tell how middle-aged men and fathers of families discussed with trembling earnestness the subject nearest their hearts, namely, the comparative merits of different brands of bootblacking; but I will content myself with giving one more incident. I suppose I shall never forget the way in which I celebrated the anniversary of my birth in 1917. I had planned

that when the last parade of the day was over I would bid dull care begone and that, armed with a late pass, I would spend a festive evening in town. I cleaned myself up very carefully and faced the inspecting officer with some confidence. He moved slowly down the ranks, and when he arrived opposite me he stepped and stared at me in a most offensive manner. He complained that my cap band was dirty, whereas if I remember right it was a new one that morning, and then, his eyes travelling further down, to my indignation he accused me of not having shaved. In an instant my thoughts reverted to the early hours long before dawn when, standing beside an uninviting sink, the washing place allotted to our barrack room, I had with the aid of some cold water scraped myself almost raw ; and contrary to all laws of discipline I raised my hand and felt my chin. I am afraid this foolish action did for me, for I was fiercely informed that I could rub away my hand on my chin all day if I liked, but that I must not do it in the ranks, and when his eye reached my buttons he called up the Sergeant Major and told him to put me on extra parade that evening for not being properly cleaned up. I met this officer, a young 2nd Lieutenant in the club at Abbeville a year later, and reminded him of the gross injustice of his conduct, he proved to be a very decent fellow and made the amende honourable.

The work at the school was very hard both physically and mentally, for we had to be trained both as gunners and drivers, gun drill with the 18 pounder and 4·7 Howitzer was exhausting work, and physical training, riding, stables, marching drill, etc., all combined to make us tired out by the end of the day. This fatigue was increased by having from time to time to be on guard duty all night. The part of this duty which I disliked most was having to go round all the stables with only a lantern for company. The horses were as a rule a well-behaved lot, and were probably as tired out at the end of the day as the cadets who rode and groomed them. There are, however, exceptions to every rule and some of these animals were cases in point. One or two of them used regularly to get loose every night, and when I opened the

stable door, hoping devoutly that I would find everything in order, I would discover the greedy brutes feeding at the corn bin.

On one such occasion a terrible thing nearly happened. On entering one of the stables on my round of inspection I was horrified at finding one of the horses loose and having an illicit feed. My horror arose not on account of the animal's greediness (he could have eaten all the corn in the stable for ought I cared), but from the fact that I should have to solve the problem of inducing an unwilling and somewhat refractory steed to quit the the corn bin and return to his stall. Putting the lantern on the floor I cautiously advanced towards the animal and with all the eloquence in my power endeavoured to persuade him to go to bed. As he took not the slightest notice of me, but went on feeding placidly, I resorted to more vigorous methods, when with out the slightest warning he suddenly darted past me, smashed the lantern to smithereens, and bolted out of the stable door. I rushed after him and discovered to my dismay that I had left the stable yard door open. The horse was standing within a few yards of it with all London before him, and my vivid imagination called up before me the terrible scene there would be on the following morning when I was charged with the loss of what was possibly the Colonel's favourite charger. It was at that moment, however, that the army system proved its value A civilian horse would simply have trotted through the gate, but this horse knew better than that. Was he not an army horse, and was it not an axiom in the army that the obvious course should never be followed? Was it not also incumbent on him to wait about a bit first? Of course. And while he was casting about in his mind for the proper strategic move I shut the yard door. I then called on another member of the guard for assistance, and between us we got the obstinate brute back to his stall. I never left the yard door open on any subsequent occasion.

In addition to the physical work we had a number of lectures on various subjects such as Gunnery, Signalling, Telephony, Map Reading, Horse-mastership, Military Law, etc., and were given a mass of notes to work up daily, but one was so tired with the

physical work that it was difficult to digest the mental fare as well. We used to do unmounted gun drill at Primrose Hill, and mounted gun drill in Regent's Park and on Hampstead Heath. The unmounted drill especially was very hard work, and we had to dash about at express speed with these guns, encouraged by the admiring gaze of the nurse maids and children who used to congregate on Primrose Hill, and spurred on by the virulent abuse and stinging sarcasm of the N.-C. O.'s in charge.

The physical training was trying to those no longer in the first flush of youth, and the riding more so. It did not matter a bit whether one could ride or not. A large number of the cadets were Australians who had practically been born in the saddle, and yet they seemed to incur the odium of the riding master just as much as anybody else, probably for the very reason that they could ride well, and had their own ideas about it. We always thought it politic to pretend that we knew nothing about anything, and when the riding master, finding that I was a Forest Officer, asked me if I could ride I tactfully replied, "not what you call riding, Sir." I shall never forget the trying times we spent in the Riding School endeavouring to perform evolutions rarely seen outside the Military tournament, and furnishing copy for Mr. Punch's humorous pictures on the subject. Great stress was laid on a proper acquisition of the aids to riding, but the aids which were there ready to hand in the shape of reins and stirrups seemed to be at a discount. Why on earth one should be compelled to mount a horse without stirrups when they are there for the purpose I never could make out.

A painful incident happened to me one morning in this connection. We received the command "Without stirrups prepare to mount," and all got into the required attitude. I had an enormous horse that day, and on the word "mount" I endeavoured to spring lightly on to his back, but with no success at all. Every muscle in my body seemed to be sprained after the various antics I had gone through, and refused to respond to my call. Lashed however by the searching invective of the riding master I made a superhuman effort, reached the saddle with feelings of

triumph, but to my bitter disappointment overbalanced and fell off on the other side. Amid his derisive comments I then mounted by the stirrup.

My deliverance, however, was near at hand. One day on my way to the riding school a letter from the War Office was put into my hand offering me a post on "the Personnel for the Director of Forestry in France," and asking me, if I cared for the job, to go and be interviewed. I had never heard of the Forest Directorate and of course had never applied for such a job, but thinking that it sounded more in my line than this everlasting mounting without stirrups I applied at once for permission to go and be interviewed. This being granted I presented myself before a certain Colonel at the War Office. He told me that a Forest Officer was required for the Forestry Corps in France, and that my name had been mentioned by a friend at the War Office as being suitable for the job He explained that timber was being supplied to our armies by British Troops working in French forests, and that although a number of the officers were connected with the timber trade there were very few officers in the Corps with a technical knowledge of Forestry, and that such were required.

He stated that two qualifications were a *sine quâ non*, firstly a thorough acquaintance with the working of saw-mills, and secondly a thoroughly practical knowledge of estimating the volume of forests. In this connection he told me that there was some difficulty between the British and French armies as regards prices of timber, and that they wanted a man who was competent to state the price on behalf of the British army. I told him that as regards the first qualification he could rule me out altogether as I had no practical experience of saw-mills, but that I considered myself competent as regards the second point. I may say here that I found the knowledge of saw-mills to be quite unnecessary, as although there were mills everywhere there were plenty of officers well up in that branch of the work, and that I never had to make any estimates nor had I anything to do with fixing the price of timber. I was further informed that if I was considered suitable

for the job I should be given a commission in the Royal Engineers and sent to France at once.

I returned to the Cadet School and a weary wait of some weeks ensued, I began to think that I had been considered unsuitable owing to my lack of knowledge about saw mills or that the papers had been pigeonholed. Meanwhile I was implored by many of the cadets to apply for one of them as my assistant if I got the job. One fine day, however, I got a notice saying that I had been appointed a Second-Lieutenant R. E., and was to hold myself in readiness to proceed to France at once (in the army no one ever "goes" anywhere, they always "proceed"). Strangely enough I left the Cadet School with considerable regret; I had been through the most unpleasant part of the course and was getting interested in the work, and when in France I saw officers wearing the Gunner's badge I always envied them. Having fitted myself out in an officer's uniform I had great fun in revisiting the school a day or two later and, among other joys, getting a smart salute from the Regimental Sergeant-Major, to whom I had always looked up as an almost unapproachable being.

When proceeding to France for the first time one always feels rather like a brown paper parcel tied up with red tape, although this comparison is perhaps a little unfair to the parcel, which is at any rate properly addressed, whereas the soldier has no idea whither he is bound. I was told to travel by a certain train to Southampton, and to report to the Embarkation Officer there. Having successfully accomplished this I was instructed to wait about for several hours and was then forwarded by steamer to Havre. It was on arrival there that I first made acquaintance with that well known officer the A. M. L. O. (Assistant Military Landing Officer) The function of this officer appears to be to keep soldiers waiting about as long as possible, and then, after examining their papers, to forward them on elsewhere. This particular A. M. L. O., after keeping us shivering on the quay for an hour or two, examined our papers and said I was to leave for Rouen that night and to report to the R. T. O. (Railway Transport Officer) on

arrival. I shall perhaps describe a journey by troop train in a subsequent article, but here I will merely state that I arrived at Rouen early the following morning and, after waiting about for two hours or more, reported to the R. T. O., who sent me up to the R. E. Base Depôt. This Depôt was situated in one of the large camps two or three miles outside Rouen, and on arrival there I reported to the Camp Adjutant, who told me to wait about until I got further orders. The waiting about this time lasted for a week but I managed to spend a not uninteresting time. The great camp was crowded with troops of every kind, some 70,000 I believe, and even the most phlegmatic must have felt a thrill of pride at being a member, however insignficant a one, of the splendid British Army.

There were a number of officers at the R. E. Depôt, and all were awaiting orders to go up the line or elsewhere, so the personnel was changing daily. Some of us slept in tents and some in wooden huts, and there was a small wooden hut as mess-room, but the ante-room was not nearly large enough to give us all seating accommodation, and I often envied the "other ranks" the commodious huts provided for them by the Y. M. C. A, Soldiers' Christian Association, and a number of other institutions, where they could read and write and find a warm place to sit in. I shared a bell tent with three or four other officers and found it a pretty chilly business, as it was cold October weather. A compensation was, however, that I was given a share in a batman to clean me up, a red letter day in my life indeed.

While at this Depôt I went through my gas test, and was fitted out with gas masks and a tin hat, none of which I ever used. They tried to prevail upon me to do various engineering projects, and seemed rather surprised when I said I knew nothing whatever about them.

At last orders came that I was to report to the Deputy Director of Forests at Rouen, where I suppose I should really have been sent direct in the first instance, for on my arrival at his office I was asked where on earth I had been and told that they had been looking for me for some time. I have, however already

remarked that the obvious course does not find much favour in the army, and after all brown paper parcels often go astray.

Colonel Oldham, D.S.O., R.E., was Deputy Director of Forests at Rouen, but as he was on leave at the time I was interviewed by his Adjutant, who explained to me the nature of the work which the Forestry Corps was doing, and gave me orders regarding the work I was to do.

(To be continued.)

VATERIA INDICA : ITS INDUSTRIAL USES.

South Kanara, Malabar, Travancore and the Anaimalai Hills are the natural habitats of the 'dhupa' (*Vateria indica*) tree. In the Mysore Ghat forests superstition attaches much virtue to it

The tree has been extensively planted in avenues; and for short distances on either side of the roads. In the unreserved lands and 'kumikis' are seen 'dhupa' in all its stages—trees, poles, saplings and seedlings.

The tree seeds annually and every three years profusely; and these avenue trees in their white flowers are a beautiful sight.

The two most important products obtained from 'dhupa' are a vegetable butter extracted from the seeds, and its resin.

For the successful management of any industry there must be in the first place a plentiful and regular supply of the produce on which that industry is dependent, secondly the produce should be obtainable on the site at reasonable cost, thirdly there must be easy means of transport, fourthly, if there should happen to be a shortage of the staple produce in any one year, the staff employed should be able to be utilized to its fullest extent in working other kindred produce; lastly, and most important of all, there must be a steady market for the outturn or profitable industrial uses for it.

All these conditions exist in respect of 'dhupa' for butter extraction in the South Kanara district. Fruits of *Vateria indica* will be obtainable in quantities to keep any machinery of ordinary capacity going for not less than six months in the year. Of course

this must remain as the staple industry and others, such as the utilization of 'dhupa' resin and manufacture of oil and butter from cocoanuts; and other seeds which are abundant in this district would be supplementary to the first Other oil-yielding seeds that are obtainable in fairly large quantities in the forests of South Kanara are :—

(1) *Anacardium occidentale.*
(2) *Calophyllum inophyllum.*
(3) *Myristica species.*
(4) *Garcinia indica.*
(5) *Hydnocarpus Wightiana.*
(6) *Mimusops Elengi.*
(7) *Schleichera trijuga.*
(8) *Pongamia glabra.*
(9) *Bassia latifolia,* and
(10) the flowers of *Mesua ferrea.*

I do not profess that the above list is exhaustive.

'Dhupa' trees are mostly within the road margins or within reasonable distance from the roads. The collection of seeds should therefore be easy and remunerative, and if the site for the installation of the plant is suitably chosen transport of produce could also be done in boats except for short distances by carts.

Fully ripe 'dhupa' fruits are preferred for butter extraction. The facts and figures arrived at by the writer under the local method extraction are noted below :—

11½ lbs. of average quality of fruits were collected; their testa was removed and the kernel bruised. This was then boiled in water in a copper vessel until the pieces of kernel could be easily crushed between the fingers. These were removed, pounded, and again boiled in water until oil and scum floated on the top. There were skimmed off to another vessel; and by boiling this, the oil was separated. This was poured into a third vessel where, after cooling, it became a solid mass. This is called the 'vegetable butter.' 5¼ lbs. of raw kernel yielded 4 per cent. of butter which works out at 89⅗ or 90 lbs. of butter per ton of kernel. Under improved methods of extraction it yields 20¼ per cent. of butter.

With the above data as basis, I append below a statement of the approximate expenditure and profit on working one ton of kernel under the local method :—

	Rs.	a.	p.
Cost of kernels at site within a radius of three miles from the place of collection ...	6	0	0
Fuel : 32 head-loads at one anna a head-load...	2	0	0
60 coolies—including men and women—at 4 annas average	15	0	0
	23	0	0
Price at the site for 90 lbs. of butter at 8 a lb.	45	0	0
Profit	22	0	0

The women of the poorer classes during the rainy season extract butter in small quantities for their domestic purposes such as lighting lamps, roasting native bread, etc. Locally it is adulterated with ghee and sold. As fruits and fuel do not cost them anything a few coppers are left as the fruit of their labour

Some notes follow on the known uses of this product :—

"It has obtained considerable repute as a local application in chronic rheumatism and other painful affections"—Indian Pharmacopœa.

"Candles made of tallow burn well but are too soft." —Gamble quotes J. H. Brougham as authority for this. But further researches might easily overcome this simple defect.

"It is useful as a basis for some ointments and plasters."—Materia Medica of Madras.

The experimental soaps manufactured from this by the soap factory at Tanur in Malabar district were reported to be quite good. The Superintendent, Government Soap Works, Calicut, states that this is an excellent fat for soap and edible purposes.

This being a solid fatty oil, a smaller quantity of it would suffice than any liquid oil in the manufacture of candles and

soaps. In bakeries and confectionaries it might advantageously and profitably be used.

Possibilities involved in this industry, *viz*, "Dhupa butter extraction' are not theoretical. In 1913 a company, called "The Eastern Development Corporation, Ltd.," installed a plant at Kallianpur—a small town situated on a river with continuous flow—easily accessible by river or road or by both from several places in South Kanara where 'dhupa' trees are abundant. This little town of Kallianpur, by virtue of its position, is capable of great development as an industrial centre. The town of Coondapur is also favourably situated in this respect.

This Company obtained from the Forest Department a lease of the right to collect 'dhupa' fruits for 30 years. A number of persons made good profits by supplying the kernels of the fruit to this Company. It stopped work a year after the war broke out and it is expected that it will resume work when conditions of freight become normal. It was making butter from cocoanuts and was carrying on investigation about the quantities of other oil-yielding seeds available in the forests of this district.

I visited the factory at Kallianpur in July 1917; but unfortunately I could not see it working as it had suspended work from 1916. However, the following is what little information I was able to collect at my inspection of the factory:—

The plant includes a 'Drying chamber.' The kernel of the fruit is put in this and by blowing in hot air a large percentage of water is driven out from the kernel which contains about 25 per cent. of water in its raw state. This has one advantage over the 'sun-drying' process inasmuch as the percentage of water in the kernel can be controlled according to requirements before it is crushed. In the latter process the kernel may become quite dry and hard and therefore it has to be softened by steaming before it is disintegrated.

Secondly the 'Disintegrator.'—This disintegrates the kerne into powder and small pieces before extraction of oil.

Thirdly the 'Extractor.'—This is called the 'Mertz' extractor manufactured in Austria. Into this the disintegrated kernel is

put and benzene is let in, the latter dissolves the oil and the liquid benzene with 'dhupa' oil in it is collected below in a reservoir. Then by steam distillation the benzene is separated from the oil as vapour. This is collected and again utilized There is only a very small percentage of wastage, *viz.*, half to one per cent. of benzene, in thus treating it. By once letting in benzene the whole quantity of oil available in the 'disintegrated' kernel is not extracted, the same operation is repeated from five to six times until the whole quantity of oil is extracted, which was ascertained to be 20 per cent. The refuse, after the vegetable butter is extracted, serves as an excellent manure in coffee plantations; and the Company was exporting it for that purpose.

The financial results could not be ascertained as the Company had suspended work a year after it was formed, owing to abnormal conditions of freight. As the estimation of the quantity of fruits available in the district arrived at after preliminary investigation was much in excess of the actual quantity obtainable, the capacity of the plant installed was also much in excess of the actual requirements for working 'dhupa' fruits. The existing machinery could not therefore be utilized to its fullest extent even if the other oil-yielding seeds available in the district were also treated here.

The total outturn of 'dhupa' fruits in the district will not exceed 15 000 to 18,000 tons in a good seed year. Assuming that 15,000 tons to fruits yield 7,500 tons of kernel, the outturn of butter under the benzene process is 1,500 tons. A ton of butter has been known to fetch Rs. 1,500 in European markets; but to be on the safe side, taking this at Rs. 1,200 per ton, 1,500 tons of butter would realize Rs. 18,00,000.

Probable Expenditure statement.

	Rs.	a.	p.
The cost of 7,500 tons of kernel to be supplied at site at Rs. 13-8-0 a ton allowing a lead of 20 miles at 6 annas a mile per ton ...	1,01,250	0	0
Cost of establishment per year including one engineer at Rs. 1,000 per mensem ...	35,000	0	0

	Rs.	a.	p.
Cost of labour—100 coolies a day for 365 days in the year at 5 annas a cooly per day ...	11,406	4	0
Cost of freight at Rs. 100 per ton on 1,500 tons (during the war it went up to Rs. 500 a ton)	1,50,000	0	0
Other expenditure for benzene, firewood, chemicals, etc., etc.	1,00,000	0	0
	3,97,656	4	0
Profit ..	14,02,343	12	0

The cost of plant, its installation, transport charges, acquisition of site, etc., should, even after allowing a very wide margin, not exceed 5 to 6 lakhs of rupees This enormous initial outlay would therefore be realized in one good seed year. I have been very lavish in my expenditure; this is done only with a view to show that, in spite of this, the industry is one with more than a hundred per cent. profit. If in India itself the outturn of butter could advantageously and profitably be utilized, which is very probable, the profit would be still greater.

As the trees seed profusely every three years, there is absolutely no fear of any loss as the enormous initial outlay will not be required when once the plant is installed and the site has been provided with necessary buildings.

Another important product from this tree is its 'resin' This is the white dammar met with in the bazaars of Southern India. Specimens differ much in colour, fragrance and density, some being of a light greenish colour, dense, homogeneous, and vitreous on fracture, whilst others are yellow, amber coloured and vesicular. These differences apparently arise from the mode and season of collection and the age of trees producing them.

Artificially the resin is extracted by wounding the bark or making incisions in it, and then scraping off the exuded resin from the bark. It also exudes occasionally and spontaneously from the bark according to the age of the tree.

Though this resin is useful for many purposes, it has not hitherto received the attention it deserved on any large commercial scale. The local fishermen collect and use it for caulking their boats.

The following notes give the uses of the resin :—

"The chief value of the tree is for its gum resin which makes an excellent varnish like copal."—Bourdillon.

I found that when pounded into fine powder, it freely dissolved in turpentine and also in kerosene oil.

"It can be used as substitute for pine and other resins imported from Europe and as a basis for some ointments and plasters." "With the aid of heat and the addition of a small proportion of camphor, it is easily soluble in spirit."—Pharmacopœia of India.

"The resin," says Mr. Gamble, "was mixed with cocoanut oil and rolled into candles which burnt with a heavy dark smoke," but the resin by itself burns with a clear light giving off a pleasant smell. A candle of this kind weighing one and a half tola, made by the writer, burned steadily for 25 minutes.

In Roman Catholic Churches in South Kanara I have seen the powdered resin used. Owing to the high prices of lubricants imported from foreign countries during the war, this, mixed with other substances, was tried in a factory at Goa and found to be quite good for lubricating purposes.

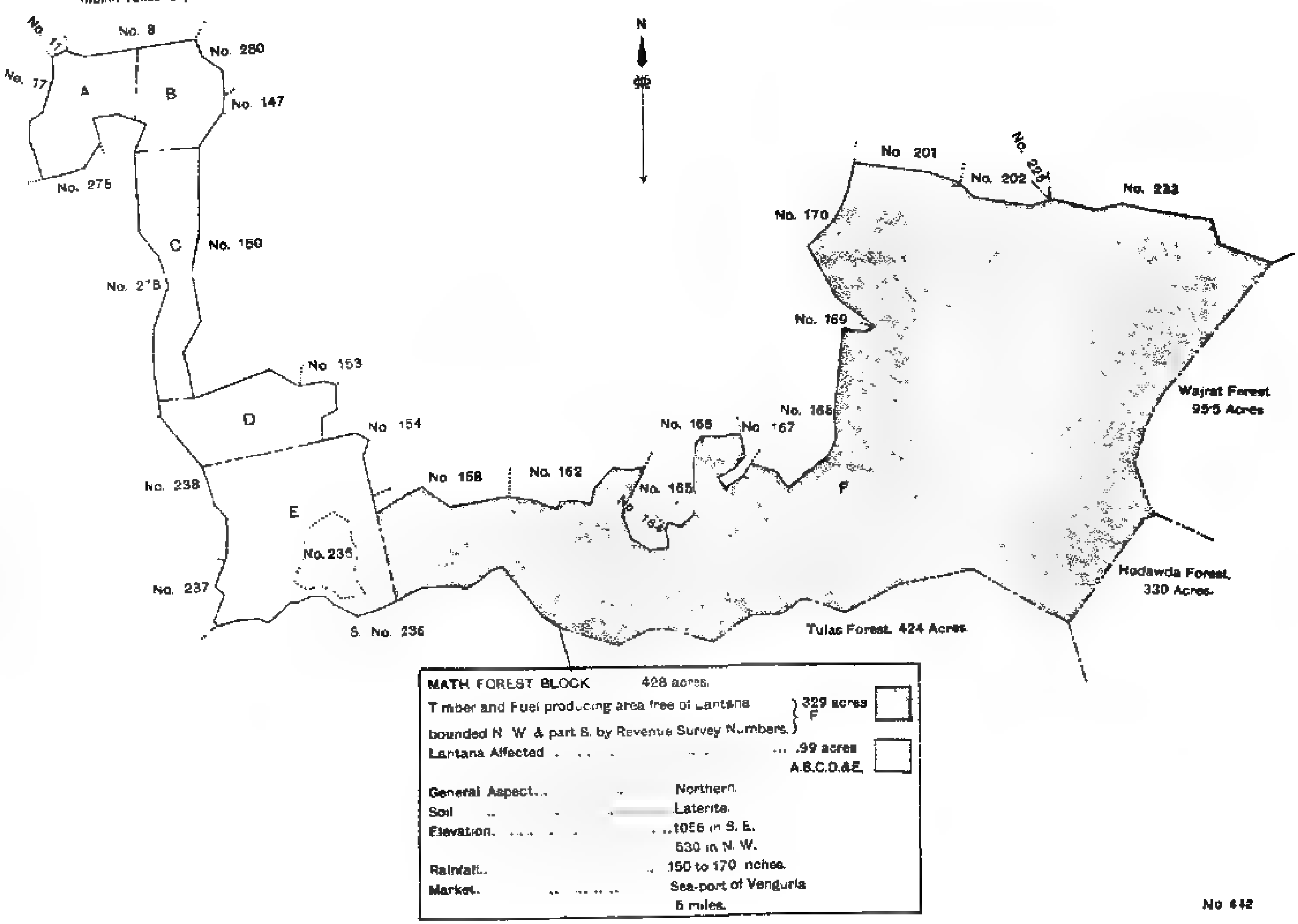
Any defects in the substances manufactured from 'dhupa' butter and resin compared with corresponding substances manufactured elsewhere should be investigated by experts, and for such research work, the Forest Department, even in its present undermanned state, could supply samples of resin and butter in sufficient quantities at reasonable cost without much inconvenience.

C. K. MENON.

30th September 1919.

The article is suggestive of possible industrial developments and research into the products of *Vateria indica*. Our information on the subject is to the effect that the outturn of seeds is too uncertain and periodic to support an industry, but the fact that it was actually started in pre-war days indicates that this objection is not insurmountable.—HON. ED.]

PLATE 13.



No 442

LANTANA IN THE MATH WORKING CIRCLE OF THE SAVANTVADI STATE FORESTS.

The Math Working Circle comprises four blocks of forests, *viz.*, Tulas 424 acres, Hodavda 330 acres, Vajrat 95½ acres and Math 428 acres, as shown on the accompanying map. Of these 428 acres nearly 99 acres, the unshaded portion, was affected by lantana.

2. No notice seems to have been taken of its appearance and development in the early stages of forest management, probably it was not realized at the time that lantana was capable of exerting any but a very slight effect on forest growth. In 1907, however, owing to certain grave departures from the provisions of the sanctioned Working Plans introduced in 1899-1900, the Political Agent secured the services of an Imperial Forest Officer from the Bombay Government with a view to obtaining expert advice on the future management of the forests and it was then that Mr. Napier, the officer deputed on the work, pointed out that early measures should be taken to deal with lantana, which had spread over the whole of the north-western limit of the Math forests in an impenetrable mass, suppressing all tree growth. He dilated upon the menace the pest was likely to prove to the future development not only of the Math Working Circle but to that of the remaining forest estate.

3. In spite of his weighty remarks and suggestions no steps seem to have been taken till 1911 when the land in question was farmed out for two years for cultivation obviously with the object of exterminating the lantana. The lessee set his tenants to work. They cut down all growth, good and bad, in true "Kumri" style, and in due course fired the whole area sowing Raggi in good time. In the following year a second crop was raised and the hillside rendered bare by the previous two years' cultivation came back for conservation to the Forest Department.

4. Satisfied with such a successful issue the department rested on its laurels, but alas! lantana was not so easily to be subdued.

Here was an ideal bed for its rapid development, the roots left by the cultivators began to throw out shoots and by 1914 a nice young crop, the tender stems and leaves of which looking far more attractive than the bare hillside, was in undisputed possession of the 99 acres, things were as bad as at the beginning of 1911.

5. Now commenced a second campaign against lantana. The very first step to be taken was to decide upon some quick growing species for planting up the block to be dealt with, the whole affected portion having been divided up into five blocks. Bamboo (*Dendrocalamus strictus*) was decided upon and the block marked E, area 37 acres, was taken in hand for obvious reasons. Lantana was dug up and pulled out by the roots and 2,500 bamboo one-year-old culms with root-stocks were put at a distance of 30 feet in lines 30 feet apart. This species of bamboo besides being a fast developer when planted with root-stocks has an excellent market value. In four years each clump, 2,002 having survived, had from 12 to 16 strong culms Lantana was thus pushed back 37 acres It appeared sporadically in this block from year to year but was successfully dealt with by admitting cultivators to remove it for rab material free of charge. This year to finally deal with its eradication in this portion, the plantation has been leased out for cultivating the intervening spaces on the conditions that the lessee earths up the clumps, uses no fire and grubs up such lantana as appears during the pendency of his lease besides paying Rs. 6 per year as assessment.

6. Simultaneously with the bamboo plantation work described above it was decided to deal with the plots A, B, C, D. There is very little lantana in A, area 12 acres Here dibbling of seeds of the species mentioned below was done 4 × 4 after removing lantana by the roots :—

Terminalia tomentosa.
Terminalia paniculata.
Acacia Catechu.
Pterocarpus Marsupium.

B, C and D were leased out for two years, but the early monsoons of 1918 upset all calculations and rendered no measures possible. This year, however, the following has been done :—

B—area 14 acres—contained a very sparse growth of lantana. The whole plot has been ploughed and sown with Raggi, plantings of Khair (*Acacia Catechu*) and Honne (*P. Marsupium*) seedlings have been effected along the ridge of the hill.

C—area 18 acres—contained a fairly dense growth of lantana. The lantana was cut and burnt, pulse was sown after hoeing and seed of *Anacardium occidentale* (cashew nut) was dibbled in 18′ × 18′ over the entire plot. Cashew nut is a fast growing tree, it branches quite low forming a compact umbrella-like crown. In the fourth year it begins to yield an income, which is derived mainly from its fruit, which is in great demand.

D—area 18 acres was similar to C. The lantana was cut down and burnt and the whole plot except a strip along the submit, where huge laterite masses prevented it, was ploughed and sown with Raggi. It is proposed to plant up this plot with *Dendrocalamus* next year.

7. The following gives a summary in brief :—

(1911).

Ninety-nine acres farmed out for cultivation having for its object the extermination of lantana.

Expenditure—No Government outlay, on the contrary an income of Rs. 856 10-8

Result—Lantana temporarily destroyed above ground.

Outlook—Financial *nil*. Nothing of any economic value was established, rather the lantana roots were stimulated and were given a free field for rapid development

(1914).

Thirty-seven acres taken in hand. Lantana removed by the roots and bamboo planted in the area cleared.

Expenditure—Rs. 123-8-6.

Result—Lantana fairly under control. Bamboo established in four years' time with minor clearings free of cost.

Outlook—Financial—Growing stock worth Rs. 2,000 created and capable of yielding Rs 200 to Rs. 500 annually.

(1917).

The whole 99 acres including the bamboo plantation were proposed to be dealt with Rs 20 per acre were tendered for, a total expenditure of Rs. 1,980 was therefore called for Proposal abandoned.

(1918 and 1919).

Plots A, B, C and D farmed out for cultivation on condition that lessee besides eradicating the lantana establishes a new crop of forest growth at his cost, taking the produce of the grain cultivated in payment of his labour.

Expenditure—Nil.

Result—Plot A rid of lantana and ground covered with jungle-wood species.

Plot B rid of lantana and seedlings of Khair and Honne planted.

Plot C—lantana eradicated and 160 seers of cashew nut dibbled.

Plot D—lantana eradicated and to be planted departmentally with bamboo hereafter.

Outlook—Financial—A, B will produce nothing for the time being—a small expenditure for tending will be incurred for ten years.

C is expected to yield Rs. 200 to Rs. 300 from 1925, in the meantime tending will cost about Rs. 15 to Rs. 20 annually.

D is expected to cost Rs. 150 for establishing bamboo next year. From 1925 a return of Rs. 100 to Rs. 200 is expected.

8. It is confidently hoped that the experiment made this year will be more successful than the past one and in the space of a few years the menace will have completely disappeared.

9. There still remains the question of dealing with the lantana growing on lands outside and adjacent to the forests. The matter has been taken up, the land-holders are being made to co-operate and in course of time it is expected that lantana will be a memory of the past.

W. E. PEREIRA,
Chief Forest Officer,
Savantvadi.

July 1919.

HOPEA PARVIFLORA—FURTHER NOTES ON.

On page 276 of the *Indian Forester* for June 1918 I stated, "It seems to me that coppicing will not result in success. In the Shankaranaraina range of North Mangalore Forest Division, Coupe No. 1 of Sublady reserve is under felling, the stumps of *Hopea parviflora*, kiralbhogi, trees are coppiced. Observations will be made on this point and published in these pages."

Coupe No. 1 of the block was felled in November to January 1917-18. I inspected this coupe half a dozen times between March 1918 and July 1918; but I did not observe any kiralbhogi stumps above 24″ in girth having sent forth coppice shoots. Coupe No. 2 of the block was felled in October to January 1918-19. Between February and July 1919 I inspected this coupe thrice.

All the kiralbhogi stumps in the two coupes were counted and their girth measurements were taken. The results are noted in the tabular statement below:—

SUBLADY COUPE NO. 1.

1″—6″	″—12″	13″—18″	19—24	25″—36″	37″ 48″	49″—60″
187 / 185	51 / 51	20 / 10	17 / 3	35 / 0	18 / 0	9 / 0

61″—72″	73″—84″	85″—96″	97″—108″	Total	Percentage of success.
8 / 0	5 / 0	1 / (	0 / 0	351 / 249	70 94

SUBLADY COUPE NO. 2.

1"—6"	7"—12"	13"—18"	19"—24"	25"—36"	37"—48"	49"—60"
$\frac{98}{54}$	$\frac{108}{22}$	$\frac{38}{5}$	$\frac{2}{0}$	$\frac{2}{0}$	$\frac{2}{0}$	$\frac{1}{0}$

61"—72"	73"—84"	85"—96"	97"—108"	Total.	Percentages of success.
$\frac{1}{0}$	$\frac{1}{0}$	$\frac{0}{0}$	$\frac{1}{0}$	$\frac{254}{81}$	31·89

[NOTE.—The numerator shows the total number of stumps under each girth class, and the denominator the number of stumps having coppice shoots. Up to 24" it is arranged under 6" girth classes and above 24" under 12" girth classes.]

It was noticed that coppice shoots were absent from stumps above 24" in girth, and the percentage of stumps below 24" in girth having shoots was 90·54 in Coupe No. 1 and 32·92 in Coupe No. 2.

In 1918 the monsoon broke unusually early, *i.e.*, on 25th March, but in 1919 only at the end of May. I attribute the greater percentage of success in Coupe No. 1 to the earlier rains which prevented the stumps from drying up as they often do during the hot weather. The stumps of trees in Coupe No. 2 had to endure the rigour of the hot weather for two months longer than those in Coupe No. 1.

The average height of the stumps was between ½" to 1½', and in no case above this. The average height of shoots in Coupe No. 1 was 4 ft. and in Coupe No. 2, 5 inches. The height of the highest shoot in Coupe No. 1 was 6 ft. 3 inches.

Mr. A. R. Narasimha Ayyangar, District Forest Officer, North Mangalore, inspected this observation area on 13th January 1919, and he was very much interested in it.

Not satisfied with my observations in these coupes I inspected also Chittur, Coupe No. 3 of Chittur Working Circle in Coondapur range. Here, too, I did not observe any kiralbhogi stump above 24" in girth with shoots. This coupe also enjoyed the benefit of the earlier rainfall of 1918.

The above observations go to show that in a coupe where kiralbhogi forms a fair percentage of the stock fellings cannot be based on the supposition that bhogi trees will coppice freely; that in this part of the country the best season for felling and coppicing the trees is from the middle of March to the middle of May so that the stumps may get the benefit of the rains before the bark gets dried up.

24th August 1919. C. K. MENON.

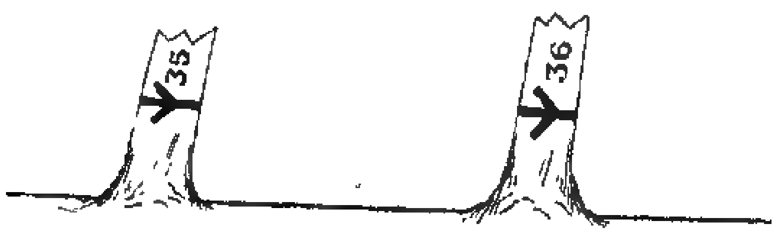
CHECKING OF STANDARDS IN COPPICE-WITH STANDARD COUPES.

The subject of marking and checking standards in coppice-with-standard coupes is reopened at intervals as the method gets refined in the crucible of experience and the freshness of suggestions explains the clemency of the Honorary Editor of the *Indian Forester*, in waving his resolve to close this hackneyed subject.

Mr. A. Wimbush in the May 1917 number of the Journal expounded the methods of marking adopted to ensure the fulfilment of the purposes aimed at.

Mr. H. W. Starte in the August 1919 number states that as an improvement over the existing system in Burma of reserving and marking by groups more or less scattered throughout the coupe, the reservation in parallel strips was adopted for facilitating and checking standards, during the working and at the expiration of contract.

In addition to this method of marking, I get the sequence of numbers on the standards, *i.e.*, the position of each succeeding standard, indicated by an arrow-head marked on the tarred ring itself as shown in the rough sketch given below :—



This ensures a very rapid checking of standards as the checking men can run from standard to standard serially.

To economize tar and save labour, the arrow head is not marked separately below the ring or above the number, though this would make it very clear.

A. RAJU NAYAKAR,
District Forest Officer, Vizagapatam.

WALTAIR,
Dated 10*th September* 1919.

REVIEWS AND EXTRACTS.

AEROPLANE TIMBERS.

BY GILBERT R. KEEN.

(William Rider and Son, Ltd., London, 1919.)

1. Those of us who were connected with the supply of aircraft timber in India during the war will recollect the feeling almost of dismay at the standard required of timber before it could be considered suitable for use in aeroplane construction The camel and the needle's eye was a simple problem by comparison. A perusal of the book now referred to tends to confirm those first impressions. Yet it is a fascinating study and Mr. Keen is to be congratulated on his handling of a difficult and extremely technical subject in an interesting and popular way. His book on "Aeroplane Timbers" should find a place in every technical library in India, as a lucid and well got up introduction to an intricate subject.

The author describes the structure, formation, mechanical and other properties of the chief European and African timbers used in aircraft construction and illustrates his theme by well reproduced micro-photographs showing the structure of the wood and so on The anatomy of wood also comes under review, and even if the nomenclature may not always gain the approval of the fastidious structural botanist, the descriptions are popular and easily understood. The testing of timber forms an interesting chapter and is perhaps the best part of the book. It is hoped Mr. Keen in future editions will see his way to give the actual figures for transverse, compression, tension, shearing and other strains of the various timbers he describes as these would be of the utmost value in determining the suitability of Indian timbers, which, so far, have not been very systematically tested for the purpose of aeroplane construction. The concluding chapters of the book deal briefly with proper systems of conversion and storage and seasoning, while the last chapter deals with the various systems of timber measurement in use, matters which are of practical utility

to the Indian forester to whom measurement by cubic feet is the only system of measurement known as nearly universally applied in India. A brief index concludes the little volume and Mr. Keen has managed to get a wonderful mass of information into the 78 pages of his contribution to aircraft timber knowledge, and its perusal can be safely recommended to all interested in aircraft construction.

HANDBOOK ON AIRCRAFT TIMBERS

BY GILBERT R. KEEN.

(Superintendent of Government Printing, India, 1919)

2. The handbook is a resumé of instructions and specifications issued by the Indian Government during the war for the guidance of officers dealing with aircraft timbers, both as regards selection and testing. The directions are necessarily very technical and can be treated as an advanced course in the study of a subject commencing with a perusal of Mr Keen's book on "Aeroplane Timbers."

A. J. G.

FOREST WORKING PLANS.

BY A. B. RECKNAGEL, B.A., M.F., PROFESSOR OF FORESTRY, CORNELL UNIVERSITY.

The general plan of the book is to give in Part I the basis of working plan compilation, the various methods of calculation, and outline and discussion of various types of working plan headings and then in Part II a brief outline of working plan practice.

Part I, Chapter II, is of very great interest to Indian Forestry. In clear and concise language it gives all the important methods of calculating the possibility in France, Switzerland and Germany with also an American and an Indian method. Each method is accompanied by a numerical example, with comments on the advantages, disadvantages and applicability of the method.

A table on page 91 shows the possibility calculated from equivalent data under the several formulæ and brings out the comparative value of each.

To those of us who are accustomed to the wearisome task of puzzling this out in a foreign language Chapter II is a veritable blessing.

It must not be thought that this is merely a compilation. It is full of original comments and suggestions.

Part II gives a brief account of the development of working plan methods in all the important German States, France and Austria and a more detailed description of the principles of the latest methods. This is the first time we have seen this so completely treated in English.

If we may criticize so excellent a production we would suggest that the history of the development of management in France leaves something to be desired.

One rather gathers that France is still bound by the rigid fixed period allotment with compact periodic blocks.

This is hardly the case. The French were always more elastic than the Germans in the length of the period, basing it rather on the time necessary for regeneration than in the more empirical manner of the Germans. After the stage of fixed periods and compact periodic blocks, the stage of fixing periods for a limited time only arose and the French finally evolved the method of a floating periodic block (Quartier bleu) with quick revisions which is at least as elastic as any of the modern German methods and allows the fullest play to sylviculture and the vagaries of natural regeneration.

We would add, moreover, that the Indian method given is being rapidly replaced by better systems of management.

We thoroughly agree with the continual driving home of the point that working plans should not be filled with extraneous matter.

According to Professor Recknagel brevity is the soul of working plans.

The following quotations are pregnant with meaning for many of us—

" Simplicity and brevity are the keynotes. '

" In the interests of clearness and brevity data should be tabulized wherever possible."

Before a revision "the supervisor (D. F. O.) has to report about the execution of the working plan, the experiences gained thereby, and about the essential results of the management, the changes in the condition of the forest, *to express himself about the fundamentals of the working plan and to base suggested changes on detailed data*." The italics are ours. The duty of a D. F. O. does not consist in merely carrying out a plan but it is his business to find out what is wrong, how to put it right, what data are needed for this and to set about getting that data.

6. Altogether this is the best book on the subject we have read in English, and though it cannot entirely replace the other text-books it goes far towards it.

It is published by John Wiley & Sons, New York, but can be obtained from Messrs. Chapman & Hall, 11, Henrietta Street, Covent Garden, London, at 8*s*. 6*d*

S. H. HOWARD, I.F.S

PACKING BOXES WITHOUT NAILS

Arrangements are being made in Great Britain for increasing the output of a novel and ingenious form of packing crate or box. It requires no nails, no screws, no hinges, no wires ; it is collapsible, and, when put together, is capable of holding any kind of merchandise. Rigidity is obtained by a system of interlocking parts. A special method of sealing the cases has been adopted to render the work of the pilferer more difficult. With the ordinary nailed-up box it is an easy job for the railway thief to apply a jemmy or a nail lifter, and restore the original outward appearance of the packages after he has extracted the contents. With this new crate it is impossible to extract any goods without leaving obvious signs that the package has been tampered with. Another advantage in these days of congested transport is that "returned empties" take only one-fifth of the space occupied by the non collapsible box.—[*Indian Engineering*, 10*th January* 1920]

VOLUME XLVI NUMBER 5

INDIAN FORESTER

MAY, 1920.

A SUGGESTED GENERAL FOREST ORGANIZATION FOR THE MADRAS PRESIDENCY.

The general Forest Organization of the Madras Presidency for the purpose of obtaining efficiency and ensuring progress may be divided into the following departments :—

No. *I. Conservation.*
" *II. Production.*
" *III. Forest Engineering.*
" *IV. Commercial.*
" *V. Correspondence.*
" *VI. Accounts.*
" *VII. Research.*
" *VIII. Teaching.*

The above eight departments should be under the general control of the Chief Conservator of Forests who should be assisted by four branches of his office which should be specially for nec-

with the definite purpose of dealing efficiently, *each* with two of the departments mentioned above.

1. Thus the "*Working Plans Branch*" will deal with—
   (1) Conservation,
   (2) Production.

2. The "*Exploitation Branch*" will deal with—
   (1) Forest Engineering.
   (2) Commercial.

3. The "*Clerical Branch*" will deal with—
   (1) Correspondence and records.
   (2) Accounting.

4. The "*Education Branch*" will deal with—
   (1) Teaching.
   (2) Research.

In immediate charge of the "Working Plan Branch" should be placed an experienced Forest Officer to be called the "Controller of Working Plans" and possibly for the time being this officer may also be appointed the Personal Assistant of the Chief Conservator, although there is little doubt that the duties which go with these two posts cannot possibly be efficiently performed by only one officer and if, for the moment, any attempt is made to carry on in this way it must be at once fully recognized that the arrangement is to be merely a temporary one.

The "Exploitation Branch" will be in charge of a special Chief Exploitation Officer whose duties will be to push the exploitation of the forests subject ordinarily to the limits laid down in the sanctioned Working Plans.

The "Clerical Branch" will be in charge of an officer much experienced in Forest Correspondence and Accounts and this officer may be termed the "Controller of Forest Correspondence, Records, and Accounts."

Fourthly the "Education Branch" will be in charge of a specially selected officer at the head of a Bureau of Education, Research, and Forest Economic Information.

The above four special branches should be part and parcel of the Chief Conservator's office in addition to the general clerical staff which may be required for the routine of the general administration.

With such an organization the Chief Conservator should be well able to co-ordinate the work of all the departments under his charge and to detect and immediately remedy any break in the spoke or spokes of the wheel of his Forest Organization in general.

Turning now to the eight departments enumerated each of these must, of course, have its own immediate departmental head, and the Heads of the Departments should be as noted below :—

	Name of Department.		*Head of Department.*
I.	Conservation	...	Conservator of Circle.
II.	Production	...	Do. do.
III.	Forest Engineering		Forest Engineer of Circle.
IV.	Commercial	...	Forest Utilization Officer.
V.	Correspondence	...	Forest Inspector of Correspondence and Records.
VI.	Accounts	...	Forest Inspector of Accounts.
VII.	Research }	...	President of Research Institute
VIII.	Teaching }		and Forest College.

In the first instance it may not and probably will not be possible to find suitable heads for all these departments, but some of them, *e.g.*, Conservators are already available and an experienced Forest Officer for the Working Plans Branch ought at once to be made available ; others may be nominated when forthcoming. This fact, however, need not delay the introduction of such an organization if it is approved by the Government.

I would suggest that a beginning should be forthwith made by nominating a Controller of Working Plans who may also for the present be the Personal Assistant to the Chief Conservator. Working Plan Officers for each circle may also then be appointed as soon as they become available, for it is imperative if any

organization is to succeed at all, that the Forests of the Presidency should be brought under Working Plans with as little delay as possible. It is unnecessary at the present stage that such plans should be of a very elaborate nature, nor is it necessary to fill them up with a lot of padding in the shape of data and statistics unless it can be certified that these data and statistics are *absolutely reliable*. Plans of a simple and skeleton nature would, for the time being, in most cases suffice, provided they dealt fully with the proposed system of working the areas dealt with and the production to be obtained therefrom.

Later on, when organization improves, more elaborate and detailed plans can be drawn up.

The great object, however, now is to introduce organized working throughout as large an area as possible and have such working under definite, systematic and *efficient* control so as to ensure a continuation of policy.

Proper control will ensure correct statistics and data being collected. This the insufficient and often inefficient control of the past has undoubtedly failed to do. The Working Plans will, of course, deal at least with the sylvicultural system and "Production."

With regard to the "Exploitation Branch" there can be no doubt that before long, although not immediately, a special Chief Exploitation Officer will have to be appointed. His duty will be to make available for the market the utmost possible of the "production" of the forests to the limits of the possibility to be determined by Working Plans, and to obtain for that production the best possible prices, after meeting the reasonable requirements of the local inhabitants and community. To do this he will have to consider the improvement to transport communications, the engineering facilities which may be possible, and the various mechanical contrivances which it may be possible to introduce with a view to the saving of labour and expense. For this reason the Forest Engineering Department should be dealt with by this Branch of the Chief Conservator's office. It will

probably be necessary to have a Forest Engineer attached to each Circle and eventually in course of time a Chief Forest Engineer may be necessary for this Department alone.

For the "Commercial Department" a Forest Utilization Officer may be employed and his chief duties will be to determine and find in what particular lines and channels the products of Forestry can best be utilized, and in what way the best prices can be obtained for them. He will have to be in touch with the various commercial houses in Madras and elsewhere and be constantly on the alert to look out for new fields wherein to find satisfactory sales for the commercial Forest Products. In this line there will be unlimited scope.

The "Clerical Branch" should be in charge of a "Controller of Forest Correspondence, Records, and Accounts," and it will be the duty of this branch to see that all Correspondence, Records, and Accounts are kept in accordance with the Rules. The staff provided with the Forest Inspector of Correspondence, and the Forest Inspector of Accounts will be responsible for the inspection of the offices throughout the whole Forest Organization of the Presidency including the offices of Conservators, District Forest Officers and Range Officers, also any departmental timber or other produce sale depôts which may exist. This will relieve the Conservators and District Forest Officers of much clerical and checking work and will give them more time to devote to the more important duties connected with conservation, sylviculture, production, organization, and the development of forests within their respective charges. Of all the most urgent improvements called for, this I consider to be one of the most pressing. The past has shown most convincingly to me that so long as Conservators, District Forest Officers, and Range Officers are trammelled with the heavy clerical and account work with which they have hitherto been, it will be impossible to expect that satisfactory progress in the development and working of the forests which present needs now loudly call for.

To begin with every Range Officer should certainly be provided with at least two clerks so that one of them may deal

with general correspondence and records and the other with accounts, etc.

The Conservator's office and that of each District Forest Officer and Range Officer should be divided into two branches, *viz* :—

(1) The General Correspondence Branch

(2) The Accounts Branch.

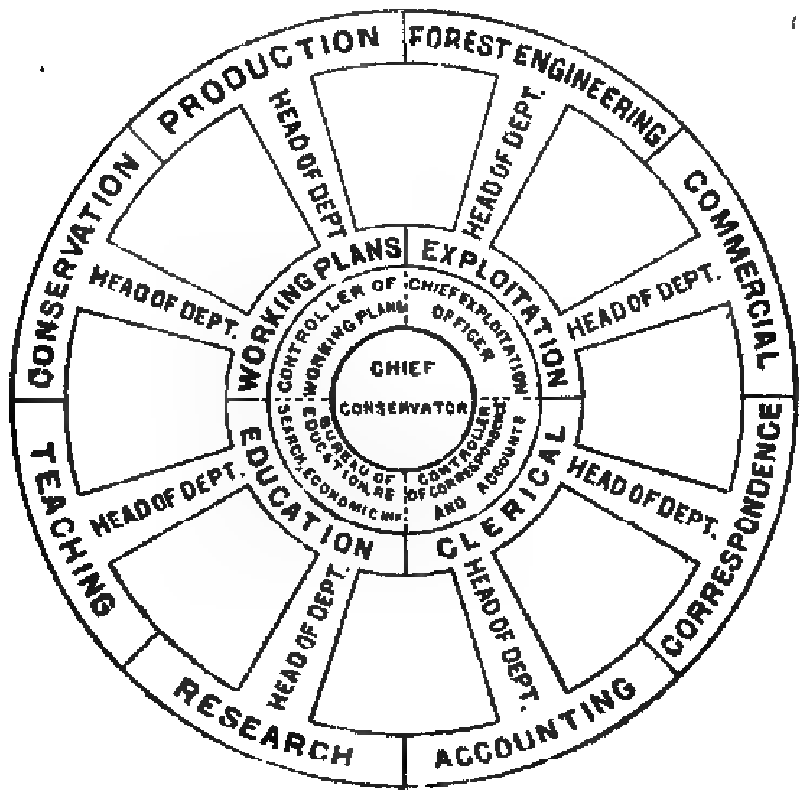
Each of these branches, although subject to the general control of the Head Clerk or Manager and the orders of the officer directly in charge of each office, will also be subject to the periodical scrutiny and examination of the Inspector of Forest Correspondence and Records and the Inspector of Forest Accounts respectively or their assistants as the case may be. The Conservators and District Forest Officers will thus be almost entirely relieved of the duties of inspecting the offices under their charge as this duty will be done and done more thoroughly, by the Special Staff to be employed for the purpose.

Finally, there remains the "Education Branch" Towards this branch at present there is in existence only the Madras Forest College, the head of which is the Principal. The forest organization needs much more than this. Firstly it ought to have a Research Institute and this can very well be run in conjunction with the Forest College with the same officer at the head of the special department, to be termed the President of the Madras Research Institute and Forest College, and the status of the officer holding this important position should be raised to that of a Conservator of Forests.

So much then for the Research and Teaching parts: but in addition to these I consider that the formation of a Bureau of Forest Economic Information in Madras is strongly called for and when formed should be attached directly to the office of the Chief Conservator in charge of a special officer to be termed the "Officer in charge of the Bureau of Forest Education, Research and Economic Information"

The above outlines the main forest organization which I would suggest for the Madras Presidency and such an organi-

zation may well be illustrated by means of a wheel as shown below :—



Wheel illustrating an efficient Forest Organisation.

Of course I am aware that it may not be possible to introduce such an organization to the full immediately, but if some such scheme were to be accepted by the Government as one which is eventually to be fully introduced into the Presidency, then a beginning ought and could very well be made and the lines along which the forest organization of the Presidency are to proceed might now with advantage be definitely laid down.

I put forward the above proposals in the earnest hope that they will receive the early and favourable consideration of my brother forest officers and of Government. I have no desire to go back on the past nor do I wish to criticise. We are now

concerned with the present and the future, and it is my earnest wish that the Madras Presidency wherein I have served the best years of my life may be provided with a suitable and up-to-date forest organization which may be able efficiently to deal with the many forest questions of the present day as also of the future, and with my experience of the working of the Forest Department behind me, during which I have never ceased to study the connected problems, I venture to claim with some confidence that if the Government is prepared to approve such an organization as I have sketched out above, the future welfare and progress of the Forest Administration in Madras Presidency will be assured.

H. B. BRYANT,

18th February 1920. *Conservator of Forests.*

FORESTRY WITH THE B. E. F.

BY J. D. MAITLAND-KIRWAN, I.F.S.

(Continued.)

Last month I described my adventures up to the point where I reported myself at the office of the Deputy Director of Forests at Rouen. It will here be convenient to give some idea of the constitution of the Forest Directorate in France, and I say advisedly "some idea" because I doubt if anyone except the staff thoroughly understood it. The Headquarters of the Forest Directorate were at Le Touquet, a town situated on the coast a few miles south of Boulogne and within easy reach of British General Headquarters at Montreuil.

The Director of Forestry was Brigadier-General Lord Lovat, K.T., K.C.M.G., K.C.V.O., C.B., D.S.O., A.D.C., and we considered ourselves very fortunate in our chief. Distinguished not only as a soldier but also as a Forester Lord Lovat, by his sense of justice, his unfailing tact, and his charm of manner, won the confidence of his subordinates and, what was perhaps of more importance still, of the French Forest Officers. It must have been a bitter trial to these officers to see hordes of British, Indians, Chinese and Germans, few of whom had ever done any forest work in their lives, swooping down on their carefully managed forests, and it was essential to have a man of tact at the head of affairs.

The Director had on his staff a considerable number of officers dealing with special branches of the work, such as Railway Transport, Road Transport, Statistics, Personnel, etc., besides the ordinary timber work, and he also had attached to him the Officer Commanding the Canadian Forestry Corps in France. The Canadian Corps was of course under Lord Lovat's command, but the constitution of that Corps was somewhat different to that of the Imperials, as will be shown later on. A French Forest Officer was attached to the Director's staff as Liaison Officer. He was appointed by the French Military Mission at G. H. Q., and his duties were, as far as I could understand, to act as intermediary between the British Forest Directorate and the French Forest Service, to allot felling areas to the former in consultation with the latter, and generally to supervise the exploitation. This post was filled by Commandant De la Roche, D.S.O., M.C

The actual work of exploitation was carried out through the agency of what were known as "Groups." There was the "Lines of Communication Forestry Group" (hereinafter referred to as the "L. of C. Group"), with Headquarters at Rouen, under Col Oldham, D.S.O., R.E., Deputy Director of Forests, the "Armies Group," with Headquarters at Le Touquet, under Lt. Col. Mallinson, D.S.O., M.C., R.E., Assistant Director of Forestry; the Central Group, the Vosges Group, and I expect other groups as well. Each Group Commander had a staff of his own, and carried out the exploitation through the agency of British Forestry Companies R. E. or of Canadian Forestry Companies.

There were in all 11 Forestry Companies R.E., and these were distributed over the L. of C. and Armies Groups, the personnel of the Headquarters Staff of both these groups being British, while the Canadian Companies were responsible for the work in the remaining groups and also for part of that in the Armies Group. Attached to all the groups were French Liaison Officers, themselves Forest Officers, whose duties were to exercise a general supervision over the forest work of the British Army, and to bring any irregularities to the notice of the Liaison Officer at G. H. Q.

There was also an Assistant Director of Forestry with his staff at Pari for dealing with various questions, and there were what were called "Forest Controls," consisting in each case of one or two officers, attached to Advanced G. H. Q., to each of the Armies, and the Royal Air Force. I do not know what exactly was the function of these "Controls," for I never came into touch with them. During nearly the whole of my service I was attached to the L. of C. Group, and consequently that is the one with the working of which I became most familiar.

Col. Oldham had on his Headquarters Staff some eight officers in charge of the different branches of work in the group, such as Personnel, Stores, Exploitation, Camps, Transportation and Saw-mills, and the Indian Forest Service was ably represented by Capt. W. A. Wallinger, who had recently retired from service in the Bombay Presidency. Capt. Wallinger had charge of all the purely forest work, and his untiring efforts were rewarded by the O.B.E. and a French decoration. At the time when I was first posted to the L. of C. Group it comprised the Forests of Eawy, Lyons, Eu Brotonne and Crècy. Crècy was later on transferred to the Armies Group, and those of Roumare, Verte and Castets were added to it. All the above forests were in Normandy with the exception of Crècy, which was in Picardy, and Castets, which was much further south in the direction of Bordeaux.

When I reported myself for duty to Col. Oldham's Adjutant, the C. O. himself being on leave, I was told that I was posted to the 11th (or as it afterwards became, the 31st) Forestry Company R.E. I was further directed to proceed at once to the Forêt de Lyons, where that Company was working, and to report my arrival to the O. C. of the Company and to the F. D. C. O. The Adjutant added that the arrangement was only temporary, and that, as I was a trained forest officer, I might look forward very shortly to becoming an A. F. D. C. O. My bosom swelled with proper pride at this alluring prospect, although I must confess that I had not the least idea what it implied. Not that I was surprised at my lack of comprehension, for I had already discovered that it was part of the Army System to mystify young soldiers by referring to everyone and everything by their initial letters

This disease is not of course confined to the Army, for have we not our own I. G. F. and our D. F. Os.? In the Army, however, it has assumed an epidemic form. I had already begun to talk with considerable fluency about C. Os. and C. R. Es. about G. H. Qs. and C.-in-C's. and had even learnt to scorn the intelligence of the young officer who said he did not know what on earth people meant when they talked about N.-C. Os. There are, however, limits to everyone's guessing powers, and I must confess that for the first few weeks I felt appallingly ignorant when told in an off-hand way by my superior officer to ring up on the telephone such functionaries as the D. A. D. L., the D. A. D. R. T., or perhaps even the D. A. D. I. W. T. (Deputy Assistant Directors respectively of Labour, Railway Transport, and Inland Waterways Transport). There were, I observed, two general principles governing the number of letters representing an officer's official title. The first of these was that the importance of any officer was in inverse proportion to that number of letters, this being in contrast with the case of letters representing official honours. Thus a man who can write C.B. or C.I.E. after his name may be supposed to be yearning for the day when his two letters will become three or his three letters four. Not so a D. A. D. I. W. T.; *he* looks forward longingly to the time when his six letters will become five, and perhaps even four, and when he will blossom forth in all the glory of a full blown D. I. W. T.

The second principle I noticed was that the amount of work attaching to any job was in direct proportion to the number of letters (or in other words that the under dog had to do most of the work).

When therefore some time afterwards the Adjutant became a true prophet and I became an A. F. D. C. O. (Assistant Forest District Control Officer), my ambition in life, never alas realized, was to get rid of that first clogging letter; and it was a staggering blow indeed to find that there was no such official as a D. A. F. D. C. O. It should certainly be part of the Army System that every officer have at least one other officer under him, for otherwise on whom is he to throw the blame when things go wrong?

I went the same evening by car to the Forêt de Lyons, about 20 miles from Rouen, and reported at the Forest District Control Office which was situated in the little village of Lyons-la-Forêt which lies in the centre of the forest. I had not quite realized where I was going, and it was a pleasant surprise when the car pulled up outside a little inn called the "Hotel de la Licorne," where I had stayed in 1899 with the Coopers Hill students of my year when we were touring in France under the kindly auspices of dear old "Billy" Fisher. The old place looked just the same, and many a pleasant evening the officers working in the Forest spent there. The Inn-keeper, Mons. Lieubray, whom a large number of Coopers Hill men will recollect, was still at his post and showed me the book in which the names of visitors were written, among them being those of a considerable number of Coopers Hill men.

The F. D. C. O. being out, I proceeded to the camp of the 11th Forestry Company, and reported myself to the O. C. who proved to be a thoroughly good fellow. He showed me my quarters, an uninviting-looking bell tent pitched in what appeared to be the coldest part of a particularly damp field, and then explained to me the work which his company was doing. As the method of working at Lyons was typical of that in the L. of C. Forests generally I will here describe it, giving details later on as I encountered them.

The F. D C. O. was in charge of all the work going on in the forest, and in control of all the units working in it, although as will appear later this control was not complete. On his staff were one or more A. F. D. C. Os. to be employed as he saw best, and their duties as a rule were to supervise the various works of felling, conversion, and extraction, to see to the despatching of timber, to advise the F. D. C. O. as regards the progress of the felling, so that fresh coupes could be applied for in plenty of time, to collect figures for the various returns which had to be made, and so on. Various other duties were according to circumstances assigned to them, and their position was at times somewhat anomalous. They were certainly under dogs as far as their position with regard to the F. D. C. O. was concerned, he being

always a Major or a Colonel and they either Lieutenants or Second-Lieutenants. In the course of their work however they had to deal with Labour Companies and other units commanded by officers with the rank of Captain or Major, and this sometimes made things a little difficult. Rank counts for a very great deal in the Army and Field Officers do not relish getting their instructions from or having their work criticised by a subaltern, even when he is technically speaking for his superior officer.

Under the orders of the F. D. C. O. were one or more Forestry Companies R. E. quartered in different parts of the forest; at Lyons there were two of these companies. They comprised a Captain and two Subalterns and a varying number of N.-C. Os. and men. They did not as a rule work as separate units nor did the men carry out the work of exploitation themselves. In the case, for instance, of the companies to which I was now attached the O. C. had charge of all the Saw-mills in the forest, two of the Subalterns were attached to Labour Companies for the purpose of supervising their work, and the third was, as far as I remember, in charge of road work. The men supplied the personnel for some of the Saw-mills and camp construction work, and also assisted in supervising and checking the work of the Labour Companies.

The actual work of felling and conversion was carried out by the Labour Companies of which there were several in each forest. These companies consisted of British, Indian, Chinese, or Prisoners of War, and they were accommodated in large camps in convenient parts of the forest. These camps were at first composed of tents, but later on wooden huts were provided and in these the labour was on the whole very comfortably housed. These Labour Companies were under the orders of the F. D. C. O. as far as their technical work went, but for discipline they were under the control of the Labour Directorate. This Directorate was split up into groups, each group comprising a certain number of Labour Companies in a particular area, and the O. C. of each company in that area was responsible to the Group Commander. In this way there was some duality of control which weakened

the authority of the F. D. C. O in dealing with his Labour Companies and especially with Prisoners of War (hereafter referred to as "P. O. W.") Companies. The officers of these companies who were of course always nervous that the prisoners would escape, considered that they were responsible merely for the discipline of the men and not for the quality or quantity of the work. The N.-C. Os. naturally took their cue from their officers the result being that whether or not good work was done by a company depended chiefly on the good-will of the Officer in Command. This tied the hands of the F. D. C O., and led to a certain amount of friction at times, but matters were made easier later on by the issue of orders which made the Labour Company Officers responsible for the quantity of work turned out by their men, the R. E. officer being responsible for seeing that it was of the proper quality.

The extraction and transport of timber was carried out by the R. A. S. C. of which there were always one or two units in each forest, and here again there was duality of control. These troops were responsible for doing the forest work and were so far under the control of the F. D. C. O.; they were however also under the orders of the A D. T (Assistant Director of Transport), and this led to continual friction, the arrangement being, in my opinion, a very bad one. I here merely state the fact and will show later the sort of difficulties which arose. The fact is that there were far too many officers in the same area In the Forest of Lyons, for instance, of which the area is only some 26,000 acres, there were over 50 officers at work, and although all of these were nominally under the control of the F. D. C. O., yet a number of them, as I have shown, owed allegiance to other officers as well This made the F. D. C. O.'s task a very difficult one, and it broke the heart of the officer who filled the post when I was first there. This was a Canadian Colonel who had had command of a cavalry regiment at the front, a man full of energy and eagerness to get things done. He found himself up against the Army system, however, and after some experience of it he decided that he preferred facing the enemy, so went back to command his regiment.

The system was, as I say, a bad one, but it was perhaps inevitable in the circumstances under which the Forestry Directorate had gradually been evolved. The Canadian system was, I think, much better, but then the Canadian Forestry Corps came out as such, and that was a great advantage. The Canadian Groups were sub-divided into districts, and the officer commanding the District had a number of companies under him, each company being responsible for the whole work of the forest in which it was stationed. There was no F. D. C. O., but the Company Commander was, as it were, F. D. C. O. of his own forest. Moreover the men of the company did the actual felling work themselves, or at any rate they did in the case of the only Canadian Company which I saw at work, and the work of conversion and clearing up was, in that particular case, left to the Labour Company. Perhaps the greatest advantage possessed by a Canadian Company was that it had its own transport, and was not dependent on R. A. S. C. units. There was thus no duality of control in this respect, and the company was self contained. The O. C. was responsible for the whole work, and he would appoint one of his Officers Adjutant, another "Bush Officer" (to look after the felling and forest work generally), a third Saw-mills Officer, a fourth Transport Officer, and so on. In this way there was of course a minimum of friction.

The following statement gives in tabular form what has already been said about the constitution of the L. of C. Forestry Group and the duties of the various officers in it —

Headquarters.	*Officers or Units*	*Duties.*
Rouen	D. D. F. (Deputy Director of Forests).	Responsible to the Director of Forestry for all work in his group.
Do.	D. D. F.'s Staff ..	Responsible for the supervision of works of all kinds in the forests of the group, under the general orders of the D. D. F.

Headquarters.	*Officers or Units*	*Duties*
Forest Headquarters (usually a camp conveniently situated in each forest .	F. D. C. O. (Forest District Control Officer).	Responsible to D D, F for all work in his forest In nominal control of all officers and units employed in his forest.
Do. ...	A F. D C. Os. (Assistant F. D C. Os.).	Entirely under the orders of the F. D. C. O, and employed in whatever way he decided.
Camps formed in any part of the forest which the F. D. C. O. directed.	Forest Companies R E	One or more Companies in each forest. Responsible to the F. D. C. O. for all the technical work in their areas.
Do.	R. A. S. C. Units. (Royal Army Service Corps)	Responsible to the F D C. O. for all horse and mechanical transport, but responsible for discipline and economy of working to the A D. T (Assistant Director of Transport).
Do.	Labour Companies	Responsible for providing the F. D C O with all manual labour required by him for any purpose, but also responsible to the A. D. L. (Assistant Director of Labour) for discipline.

Before proceeding to details it may be well to give a general idea of the sort of material which the armies required from the forests and how it was supplied. This material falls roughly into two classes, that which passed through the Saw mill and that which did not.

In all the forests there were Saw-mills working at high pressure, often day and night, and an immense amount of sawn timber was turned out. A large proportion of this was in the form of sleepers of different sizes. Then again a great deal of planking was required for various purposes, and this planking was classified under different heads according to its particular specification. One of these heads, for instance, was "Sawn Defence Timber," which comprised, as far as I remember, planking

with a waney edge required for lining the trenches, another head was "Sawn Forest Planking," denoting certain sizes of properly edged planks for building purposes. Yet another kind of planking of which we had to supply thousands of tons was termed "2½ inch road-slabs," which were used for making rough roads. "Off-cuts," or the outside pieces sawn off when squaring logs in the mill, were also sent forward in large quantities.

It will of course be appreciated that the class of sawn timber required in any month had a considerable effect on the felling and conversion operations, for it was essential that a supply of logs cross-cut to the proper lengths should be available. If for instance there was a demand for 9-foot sleepers great waste would ensue if trees had already been cross-cut to 10 foot lengths. This may seem a very obvious matter, but a feature of the work was the sudden demands which had constantly to be met, and for this reason the cross-cutting had to be watched very carefully.

A very large quantity of unsawn timber had also to be supplied. Many thousands of poles of different sizes, from 60-foot telegraph poles weighing approximately half a ton each down to small poles six feet in length and averaging 65 to the ton, had to be cut every month, and were all required for specific purposes, some for building dug-outs, others for constructing stables and other buildings, and others again for corduroying roads. These poles were classified under different letters, each letter denoting a particular specification in accordance with the object for which the poles were required, so that when we were ordered to send away, for instance, 200 tons of "O poles" or 300 tons of "X poles" we knew exactly the class of poles required. Then millions of pickets for wiring purposes had to be supplied, and there was of course a continual demand for firewood. Charcoal had also to be manufactured, as this was used as fuel in the front line trenches instead of wood so as to avoid showing smoke, and the L. of C. Group had to make and despatch about 1,500 tons monthly except in the summer.

Each forest had a monthly programme to work to. The procedure was, I think, for the various armies to inform the Q. M. G.

monthly of their requirements, and for that officer to pass them on to the Director of Forestry. His staff then divided these requirements up between the different forest groups, and, in the case of the L. of C. Group at any rate, the Officer Commanding had a conference with his F. D. C. Os. towards the close of every month at Rouen, for the purpose of discussing the programme for the ensuing month.

Previous to this conference the figures for the total allotment for the Group made by the Directorate would have been circulated to all F. D. C. Os. in order that they might make a return showing what proportion of the various items they proposed to supply from their own forests. These figures were read out at the meeting and any alterations which were found necessary would then be made. It might be found, for instance, that whereas 2,000 tons of broad gauge sleepers were required from the Group only 1,500 tons had been offered by F. D. C. Os. In this case the D. D. F. would try and get them to take on the balance between them, and a discussion would ensue regarding the capacity of the various mills. Very often a surplus of material under some head would be offered, each F. D. C. O. trying to get rid of stock of which he had a large quantity on hand, and these figures would have to be cut down. The F. D. C. Os. then returned to their forests and distributed the material, for the supply of which they had become responsible, among the different Labour Companies, and the various mills in their areas. These cut and dried programmes were often rudely upset by sudden demands for special material, the supply of which was rendered necessary by the exigencies of the campaign. Were we rapidly advancing, for instance, there would be a sudden call for road slabs and sleepers, so that we might push on with our roads and railways; were we on the other hand retiring there would be an urgent demand for pickets for wiring new lines of defence. A striking instance of this will be given in a later article.

Before leaving this question of programmes it may be mentioned that not only had the material of various sizes, sawn and unsawn, been standardized and classified under different

heads, but the number of pieces to the ton in each class had also been calculated. This was necessary in order to enable us to form an estimate of the number of railway trucks required daily, for these were often very difficult to get, and due notice had to be given. As regards sawn timber it was not of course possible in all cases to calculate the number to the ton, since some classes contained planks of varying length. In the case of planking, however, the calculation was made in what are called "Board Feet," or "Foot-Board Measure." A board foot is a piece of wood one foot square and one inch thick, and foot board measure, which is an American and Canadian system of measurement, was always used to calculate the daily outturn of the mills. By the use of certain factors it is possible to calculate the number of board feet in scantlings of any length, breadth, and thickness, and as the number of board feet to the ton had been estimated (420 was I think the figure) we always knew the number of tons of sawn timber which were turned out by the mills daily, and consequently the number of tons of scantlings of every kind on hand

Our stock of firewood was also reckoned in tons, though this was not altogether a satisfactory procedure, 2½ stacked cubic metres, or "*stères*," were reckoned to be a ton, but as this took no account of whether the firewood consisted of large split billets or of small faggots the figure could only be considered as a very average one. I have sometimes succeeded in loading just over 10 tons weight of fuel in the shape of large split billets into a ten ton truck, whereas in the case of small faggots I have often been unable to get more than about 3 tons into a waggon of the same size.

I will conclude this article by giving a very rough outline of how the exploitation was carried on; in a succeeding article I will deal with the matter in more detail.

The F. D. C. O., as already explained, would give each of his Labour Companies a definite programme for the month and would inform them as to the coupes in which they were to work. The trees to be felled would have been previously marked by the French, and the R. E. Officer in charge (either a Forestry Company

Officer or an A. F. D. C O.) would give the Labour very careful instructions as to what to fell and how to fell it. Felling would then be commenced, and would be followed by conversion into logs, poles, fuel, etc., the logs being as a rule left *in situ*, the poles piled in heaps according to different categories, and the firewood stacked in *stères*. The Horse Transport would then take the material to the road-side, and the Motor Transport would convey the logs to the mills and the poles and fuel to a dumping ground near the railway. After the logs had been sawn up into timber of the necessary specifications they would be taken to the railway by the M. T., unless there was a railway siding at the mill itself, as was frequently the case.

The material was then loaded and despatched to various centres of which Headquarters kept us informed, and a telegram was sent to Rouen daily giving details of the day's despatches. This information for all the forests of the group was sent on by Rouen to the Headquarters of the Director of Forestry each evening, and the Director was thus kept daily informed of the exact amount of material of each class despatched from all the forests under his control.

(To be continued.)

HAZARA FOREST DIVISION, NORTH-WEST FRONTIER PROVINCE.

The five *graphs* and the tabular statement attached to this note may prove of general interest as illustrating the progress of the work of the Forest Department in one forest division during a period of nearly 40 years, namely, from the forest year 1880-81 to the end of 1918-19. These statistics have been collected from annual reports and it would be a lengthy piece of work to attempt to analyse such statistics in any great detail. But the brief notes below deal with the more salient points explaining them.

2. *Area and distribution of forests.*—Except in the Hazara District there are no forests in the North-West Frontier Province under the charge of the Forest Department, and even in this district there are considerable areas of tree and scrub forest of great value

which are managed by the Civil Department and not by the Forest Department (except in so far as rules require that the Deputy Conservator of Forests, Hazara, be consulted in cases of large sales from *guzaras*, as the village forests are called) The area statistics of Hazara forests are summarized as follows :—

Reserved Forests under Forest Department :—			
Kagan Range	76·41	square	miles.
Siran ,, ...	46·57	,,	,,
Thandiani ,, ...	28·59	,,	,,
Dungagalli ,, ...	33·84	,,	,,
Khanpur ,, ...	50·68	,,	,,
	236·09	,,	,,
Reserved Forests under Civil Department (including Agror Valley)	10·39	,,	,,
Reserved Forests under Military Department	1·77	,,	,,
Guzaras (village forests under the control of Deputy Commissioner, the estimated area of *tree and scrub forest* is taken) say	50	,,	,,
Total tree and scrub forests ...	298·25	,,	,,

N.B.—The statistics dealt with in this note only refer to the forests under the charge of the Forest Department.

The whole of the forests of the Kagan, Thandiani, and Dungagalli Ranges are of the usual higher Himalayan type though deodar is by no means common in Hazara. The same applies to somewhat less than half of the Siran Range. The balance of the Siran Range and about one-sixth of the Khanpur Range consists of pure *chil* forest, the Siran *chil* being probably as good as any *chil* found in India, while the Khanpur *chil* is of approximately the same quality as that in the neighbouring Rawalpindi Division in the Punjab. The balance of the Khanpur Range consists of scrub forest in which the most important species are Olive and *phulai* (Acacia modesta), many of these forests are rapidly becoming overrun with Sanatha (*Dodonæa viscosa*) which regenerates

itself so freely and grows so densely that nothing else can obtain a footing. The scrub forests are utilized almost entirely to meet the firewood demands of Abbottabad Cantonment. It may be mentioned that there is a very considerable area of very fine hardwood forest in the Dungagalli Range, the most important species being Maple, Horse Chestnut, Bird Cherry, Oak (*Q. dilatata*), and Elm, while the Yew is also found in greater quantities than is generally the case even in the Himalayas.

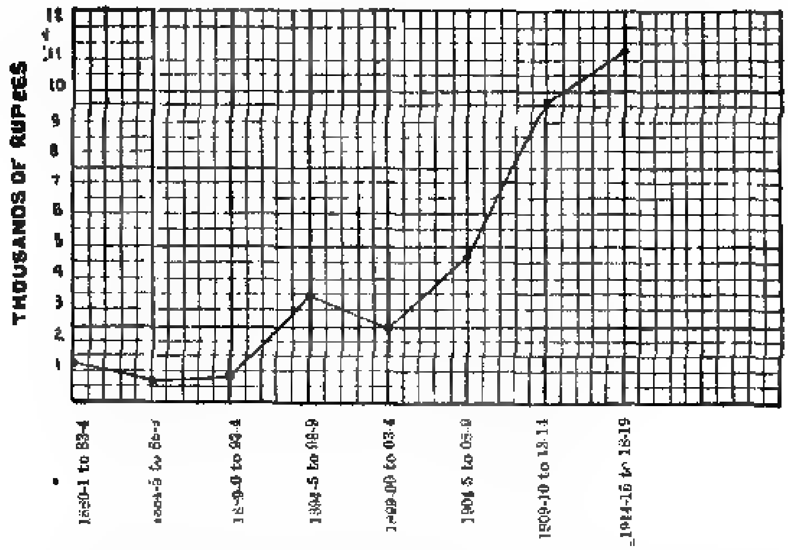
3. *Rights and concessions.*—The Hazara Reserved Forests are not at all heavily burdened with rights, except in the case of a portion of the higher hill forests of Siran Range, where vaguely defined grazing rights are resulting in the gradual destruction of considerable areas of valuable Deodar, Blue Pine, Spruce and Silver Fir forest. The only rights recognized are grazing and grass-cutting and (in one small area of Kagan only) lopping for fodder. The following areas are burdened with such rights :—

Kagan	Range	about	2	sq.	miles out	of	76	sq. miles.
Siran	"	"	13	"	"		46	"
Thandiani	"	"	$1\frac{1}{2}$	"	"		29	"
Dungagalli	"	"	$1\frac{1}{8}$	"	"		34	"
Khanpur	"	"	$5\frac{3}{4}$	"	"		50	"

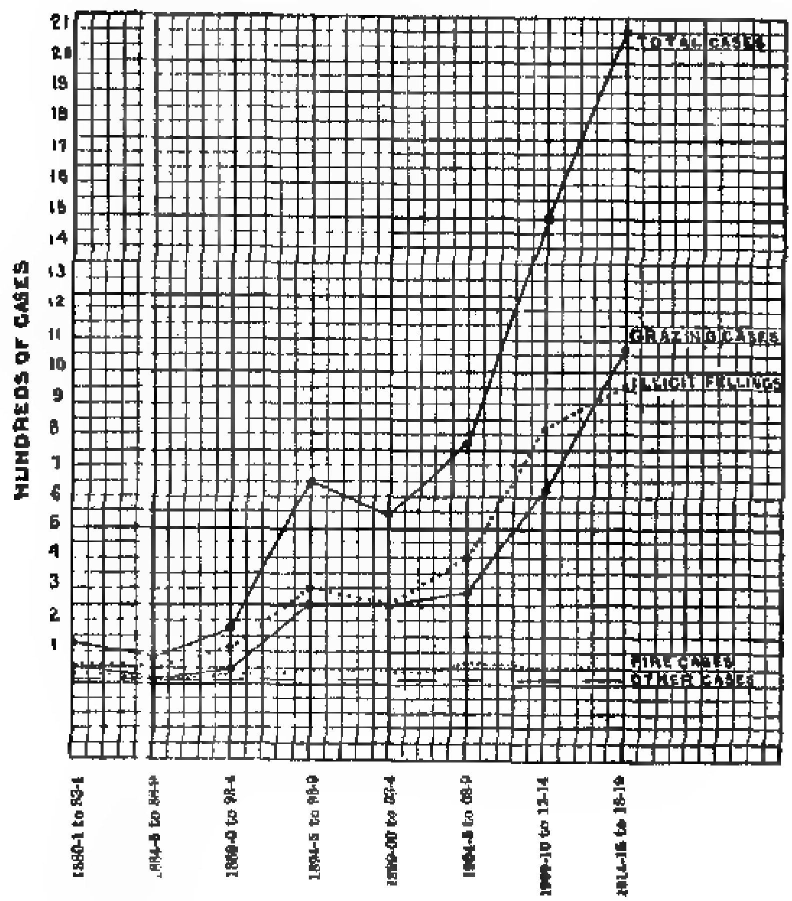
But, apart from *rights*, concessions during good behaviour to free grazing and grass-cutting and collection of small pieces of fallen wood are allowed throughout the forests except where closure is necessary for regeneration purposes or as a safeguard against landslips and erosion. These concessions were only introduced in 1918, before then forests were leased for grazing and grass-cutting to the villages concerned for purely nominal sums.

4. *Administration.*—The Hazara Reserved Forests were demarcated and settled in 1878 and were administrated as part of the old Jhelum Forest Division. It was not until about 1880 that a separate Forest Division was formed. Until 1912 the Hazara Forest Division formed part of the Punjab Circle of conservancy, but in that year the system was changed, the control of the Punjab Conservator being removed and the Revenue Commissioner, North-West Frontier Province, becoming the head of the Forest

GRAPH No. 1. COMMUNICATIONS AND BUILDINGS.



GRAPH No. 2. FOREST OFFENCES.



Department with a Deputy Conservator of Forests from the Punjab List (who has practically the same powers as a Conservator) as technical officer in charge of the Reserved Forests (except Agror Valley forests which for political reasons remain in charge of the Deputy Commissioner since they are close to and on the slopes of the notorious Black Mountain).

The gazetted, subordinate and clerical staff of the Hazara Division is borne on a combined Punjab N.-W. F. P. List but in no other respect is Hazara connected with the Punjab Circle. The Inspector-General of Forests is inspecting and controlling officer and exercises such Conservator's powers in technical matters as are not delegated to the Deputy Conservator of Forests.

5. *Management.*—No working plans worthy of the name existed for the Hazara Reserved Forests until four plans based on the Selection System were prepared by Mr. A. V. Munro for the Kagan Valley, Siran Range, Thandiani-Dungagalli Ranges and Khanpur Range and sanctioned between the years 1900 and 1907. These plans are still in force but require revision very badly.

6. A few notes dealing with the statistics now published may prove of interest:—

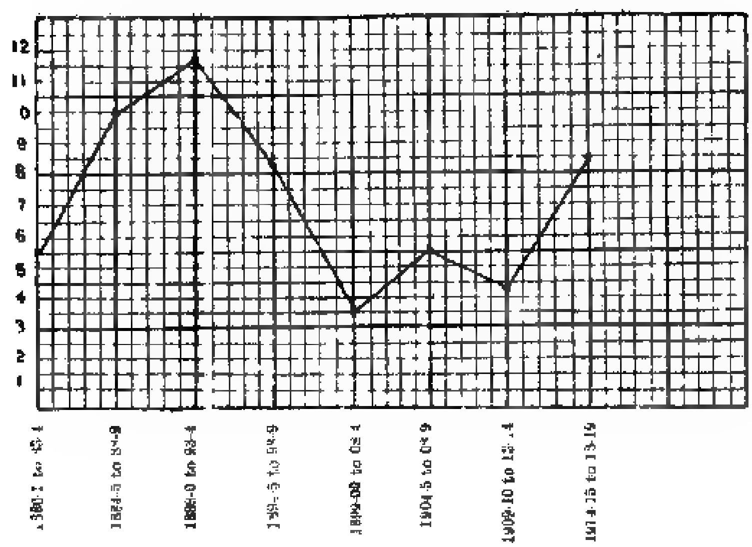
(i) *Communications and Buildings.*—Although the graph shows a fairly steady rise in expenditure under this head Hazara can only be described as most badly equipped with both good roads and buildings. Forest communications consist entirely of bridle-paths and inspection paths, many of which are badly aligned and rest houses are not adequate. The engineering problem will prove one of the most important that will come up for solution at the revision of working plans, since land transport is essential for quite two-thirds of the forests owing to lack of large rivers.

(ii) *Forest offences.*—The rise in the number of forest offences during the period dealt with in the statistics is remarkable. The small number shown between 1880 and 1894 can only be ascribed to the fact that

the staff of the Forest Department was entirely inadequate so that forest offences were committed with complete impunity over large tracts of the division. From 1894 onwards the graph displays a practically steady rise in the number of offences from under 200 to 2,000 cases, the upward tendency being most marked during the last two quinquenniums. This rapid rise can be ascribed to the effects of a very large increase of staff both gazetted and subordinate and to greatly increased pressure on the reserved forests following on a considerable increase in the population and wealth of the district with the consequent gradual deterioration of many of the village forests *(guzaras)* more especially in the Khanpur, Thandiani and Dungagalli Ranges. It is possible, too, that there was a tendency to excessive strictness in the administration of the forest law, during the past ten years and it is now the policy of the department to interfere as little as possible with acts which, though technical offences, do not cause real damage to the forest estate.

(ii) *Forest Areas burnt*.—The "graph" shows very great variations from quinquennium to quinquennium and to get any real idea of the position in Hazara as regards forest fires, it is necessary to study the tabular statement which gives statistics year by year. Such a reference will immediately demonstrate the "periodicity" of forest fires in Hazara, an outbreak of incendiarism occurring in the earlier part of the period under review practically biennially and more recently at intervals of three or four years. The *Hazarawal* is convinced of the necessity of burning the low-lying scrub and *chil* forests at intervals of not more than four years in order to improve the growth of grass and to rid the forest of the dense

GRAPH No 3
FOREST AREAS BURNT



covering of pine needles which not only chokes the growth of grass but causes death and injury to his cattle by its slippery surface. Thus despite punitive closures and communal fines (which are legal under the Hazara Forest Regulation) it has always proved impossible to prevent nearly all the *chil* forests and most of the scrub forests being intentionally fired at intervals of three to four years—the higher hill forests of Kagan, Siran, Thandiani-Dungagalli Ranges are practically immune from forest fires.

(iv) *Outturn of Forest Produce.*—*Timber* outturn has increased very much since 1899, the increase following on the gradual introduction of working plans (see para. 5).

The upward trend is accentuated after 1909 as the opening of the Havelian Serai Kala Branch of the North-Western Railway broadened the market for Hazara forest produce and enabled the Siran Chil forests to be exploited whereas before then there was

no demand as the forests were so out of the way. The war has had its effect in the last quinquennium and has made it possible to carry out almost the whole of the Main fellings prescribed and to carry out Improvement Fellings and Thinnings on a larger scale with a view to meeting war demands in Mesopotamia and in India.

Firewood outturn remained fairly steady until the year 1909, but since then has shown a steady rise due mainly to the increase of garrisons and civil population especially in and around Abbottabad and in the Hazara Galis Cantonments even in peace time, while the great increase in the number of troops stationed in Abbottabad and the Galis Cantonments and in other parts of Hazara District during the war led to a very marked rise in the firewood outturn during the last quinquennium.

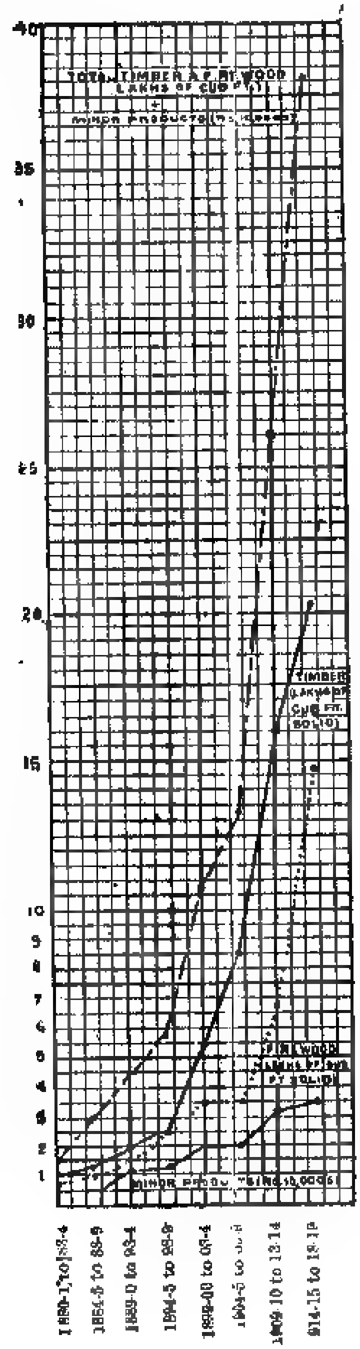
Minor produce outturn has not shown any great rise but should do so in the future when the resin resources of the Chil and Blue Pine forests are tapped and developed as they have not been up to date

(v) *Financial Results.*—The graph synchronises very fairly with the outturn graph until the last quinquennium—the war period. In the last quinquennium there was an extraordinary rise in the price of timber and firewood of which Hazara was only able to take partial advantage (in Thandiani-Dungagalli and Khanpur Ranges) since the more extensive and valuable forests were leased to a purchaser of standing trees for a period of five years at *fixed* royalties which were settled just before the outbreak of war. Recently the department has commenced a reversion to departmental management of exploitation and this change is reflected in the curve of expenditure in respect of the last quinquennium.

7 The above notes are, it is feared, very inadequate, but in these days of heavy work and inadequate staff, a detailed analysis of figures dealing with a period of 40 years is hardly possible. It

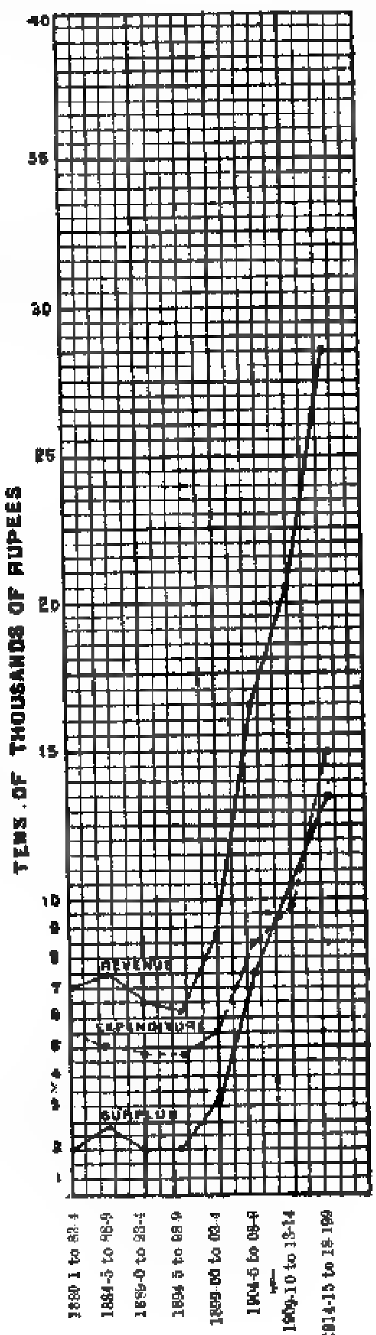
GRAPH No 4

OUTTURN OF FOREST PRODUCTS



GRAPH No 5

FINANCIAL RESULTS



is, however, hoped that this note will not be entirely devoid of interest to readers of the *Indian Forester*.

R. PARNELL,
Deputy Conservator of Forests,
Hazara, N.-W.F.P.

ABBOTTABAD :
8th November 1919.

Tabular statement illustrating the more important forest statistics of the Hazara Forest Division N.-W. F. P., from its formation in 1880-81 to the end of 1918-19 (forest years).

Year.	Forest offences					Burnt areas	Communication and buildings.	Outturn.			Financial results		
	Fires	Felling	Grazing	Others	Total			Timber thousands cft	Fuel thousands cft	Minor produce	Revenue	Expenditure	Surplus
						Acres	Rs	c.ft	c.ft	Rs.	Rs	Rs	Rs
1880-81	30	47	34	6	137	2,113	1,346	60	26	7,600	68,000	50,000	18,000
1881-82	8	31	14	4	57	108	1,588	64	167	6,147	63,500	51,000	12,500
1882-83	30	65	33	7	135	14,350	942	194	25	6,104	64,250	56,350	7,900
1883-84	13	61	23	2	99	3,716	550	48	120	6,381	88,800	68,500	20,300
Total	81	204	124	19	428	20,287	4,426	366	338	26,322	2,84,550	2,25,850	58,700
Average	20	51	31	5	107	5,072	1,106	92	84	6,580	71,131	56,462	14,675
1884-85	9	40	24	1	74	13,827	505	24	40	5,448	39,350	46,600	—7,250
1885-86	3	64	41	1	109	4,460	618	139	78	6,548	78,479	52,658	25,821
1886-87	7	57	27	4	95	27,651	430	92	80	7,790	69,814	51,575	18,239
1887-88	21	27	1	2	51	253	545	170	198	8,630	95,637	53,930	41,707
1888-89	7	59	23	3	92	1,096	512	190	144	8,901	1,01,452	62,551	38,901
Total	47	247	116	11	421	47,287	2,610	615	540	37,317	3,84,732	2,67,314	1,17,418
Average	9	56	23	2	84	9,457	522	123	108	7,463	76,946	53,463	23,483

1889-90	..	7	87	44	3	141	23,451	656	130	144	9,331	64,922	51,933	12,989
1890-91	..	34	90	19	5	148	..	435	180	164	9,742	43,956	44,307	—351
1891-92	..	10	138	30	3	181	20 294	763	264	132	11,373	75,560	48,515	27,045
1892-93	..	14	69	19	3	105	157	1,073	200	153	11,980	70 215	49,069	21,146
1893-94	...	1	187	93	27	308	11 444	923	164	192	8,344	65,126	55,386	9,740
Total	...	66	571	205	41	883	55 351	3,850	938	785	50,770	3,19,779	2,49,210	70,569
Average	..	13	114	41	8	176	11,070	770	188	157	10,154	63,956	49,842	14,114
1894-95	...	52	376	286	12	726	19,211	1,305	240	237	11,937	75,602	50,066	25,536
1895-96	..	27	328	378	6	739	6,302	1 000	227	188	10,328	63,471	44,160	19,311
1896-97	..	40	340	293	2	675	156	9,248	222	332	13,252	56,530	47,970	8,560
1897-98		39	354	244	13	650	8 857	3,773	234	185	11,325	65,234	44,844	20,390
1898-99	.	48	176	196	4	424	4,197	2,007	224	198	20,766	52,776	50,364	2,412
Total	...	206	1,574	1,397	37	3 214	38,723	17,933	1,147	1 140	67,608	3 13,613	2 37,404	76 209
Average	..	41	315	279	8	643	7,745	3,587	229	228	13,522	62,723	47,481	15,242
1899-00	.	28	245	188	3	464	1,914	2 083	231	265	18 425	63,720	50,257	13,463
1900-01	.	37	280	322	5	654	628	2,248	267	187	20,252	85,872	52,497	33,375
1901-02	...	61	212	252	8	535	3,732	2,597	390	383	25,461	83,236	51,942	31,294
1902-03	..	12	259	299	4	574	6,112	3,052	867	455	15,327	99,148	56,034	43,114
1903-04	...	29	283	255	3	570	2,902	2,325	945	504	18,969	1,00,940	64,188	36,752
Total	.	167	1,279	1,326	23	2,795	15,288	12,305	2,700	1,794	98,434	4,32,916	2,74,918	1,57,998
Average	..	33	256	265	5	559	3,058	2,461	540	359	19,687	86,583	54,984	31,599

Tabular statement illustrating the more important forest statistics of the Hazara Forest Division, N.-W. F. P., from its formation in 1880-81 *to the end of* 1918-19 *(forest years)* (concld.).

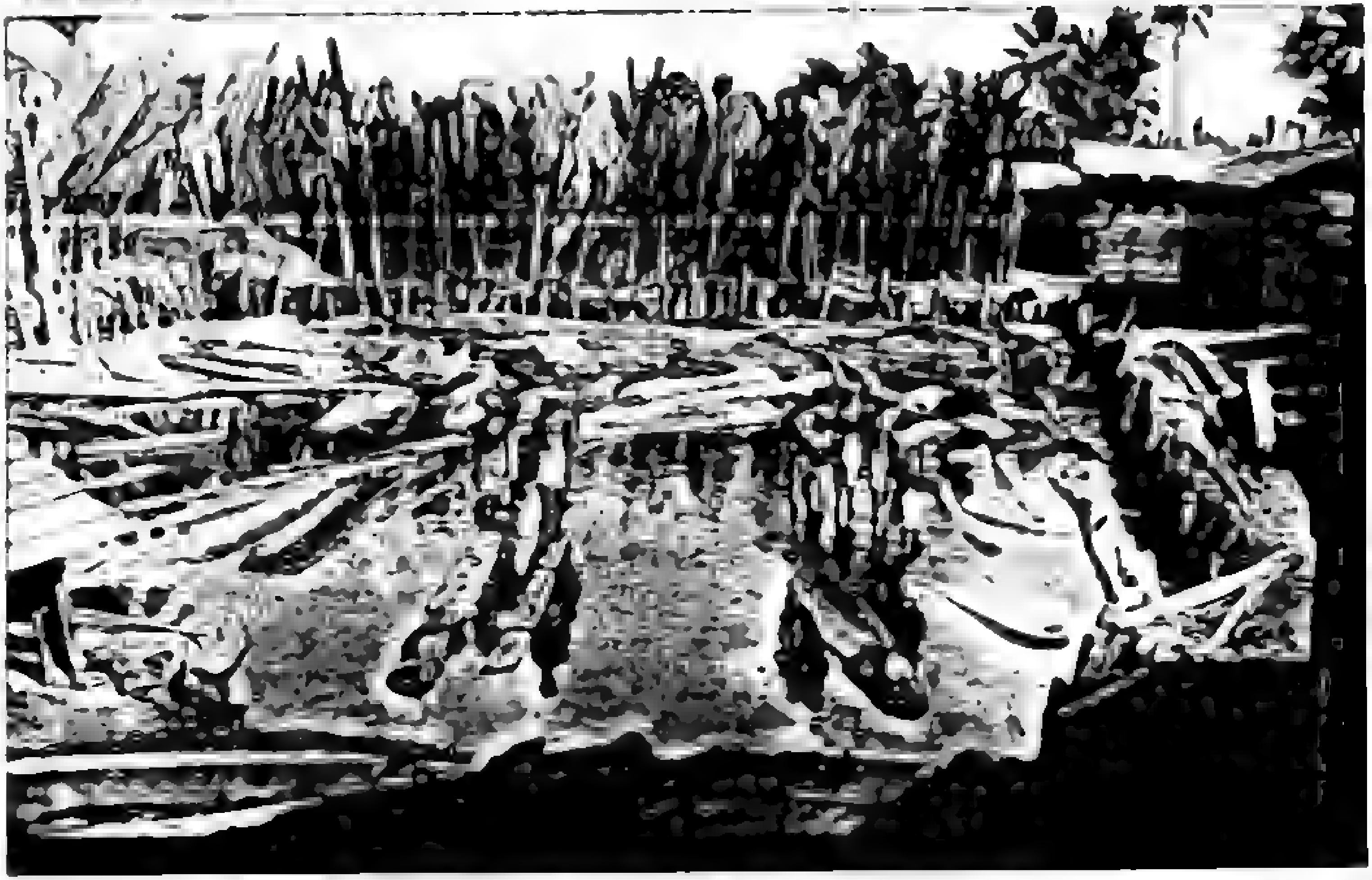
Year		Forest offences					Burnt areas.	Communication and buildings.	Outturn			Financial results.		
		Fires.	Felling	Grazing.	Others	Total			Timber thousands of	Fuel thousands of	Minor produce.	Revenue	Expenditure.	Surplus.
							Acres.	Rs	c.ft.	c.ft.	Rs.	Rs.	Rs	Rs.
1904-05	...	29	369	258	4	660	480	3,713	1,094	326	20,842	99,729	82,115	17,614
1905-06	...	25	378	289	10	702	221	5,156	1,163	450	19,847	1,50,760	93,730	57,030
1906-07	...	18	375	291	50	674	20	3,730	926	355	17,593	1,68,841	85,467	83,374
1907-08	...	99	418	298	63	908	23,925	6,522	664	306	26,666	2,31,166	89,192	1,41,974
1908-09		103	492	327	36	958	125	4,655	415	395	13,301	1,75,688	82,116	93,572
Total		274	2,002	1,463	163	3,902	24,771	23,770	4,262	1,832	98,249	8,26,184	4,32,620	3,93,564
Average	...	55	400	293	32	780	4,954	4,755	852	366	19,650	1,65,237	86,524	78,713
1909-10	...	21	501	471	11	1,004	1,514	10,998	586	287	22,391	1,26,490	76,117	50,373
1910-11	...	22	667	484	9	1,182	12,955	6,960	700	386	23,331	2,30,133	76,455	1,53,678
1911-12	...	30	1,081	592	10	1,713	5,358	7,533	533	553	41,050	1,46,509	89,901	56,608
1912-13	...	44	897	770	13	1,724	539	11,043	2,933	638	34,144	2,53,604	1,25,269	1,28,335
1913-14	...	12	1,007	860	9	1,888	206	11,812	3,383	1,524	36,881	2,53,493	1,30,858	1,22,635
Total	...	129	4,153	3,177	52	7,511	20,572	48,355	8,135	3,388	1,57,797	10,10,229	4,98,600	5,11,629
Average	...	26	831	635	10	1,502	4,114	9,671	1,627	678	31,559	2,02,046	99,720	1,02,326

1914-15	9	920	917	8	1,854	20,223	8,515	3,221	1,256	34,388	2,27,142	1,23,741	1,03,401
1915-16	56	1,429	1,029	9	2,523	183	6,887	2,200	1,336	35,744	1,87,992	1,06,876	81,116
1916-17	29	1,247	1,033	18	2,327	137	5,703	1,692	1,476	36,741	2,61,783	1,23,023	1,38,760
1917-18	25	549	1,480	10	2,064	15,996	15,729	1,860	1,461	30,805	3,30,270	1,60,700	1,75,570
1918-19	49	684	982	16	1,731	3,353	14,537	1,428	1,852	30,885	4,11,506	2,31,685	1,79,821
Total	168	4,829	5,441	61	10,499	39,892	51,371	10,401	7,381	1,68,563	14,24,693	7,46,025	6,78,668
Average	34	966	1,088	12	2,000	7,978	10,274	2,080	1,476	33,713	2,84,939	1,49,205	1,35,774

THE IMPORTANCE OF VERTICAL STACKING IN THE SEASONING OF CONVERTED MATERIAL.

Now that the various methods of the natural seasoning of timber have been brought into prominence by the seasoning experiments which are now being carried out all over India the attached photograph may be of interest as showing the importance attached to water seasoning and the vertical as well as the horizontal method of stacking converted material. I think it is safe to say that certainly as regards Upper India very little attention is paid to vertical stacking though this method is now being tried and its results being compared with those of the horizontal method under our departmental seasoning experiments. The photograph represents a view of the inside of a saw-mill on the West Coast and is taken from the breaking down saw benches. The mill deals mainly with soft woods for the manufacture of boxes for packing tea and rubber, the chief timbers being *Bombax*, *Tetrameles*, *Mango*, *Antiaris toxicaria*, *Sterculia* spp., *Vateria indica* and *Alstonia scholaris*. The timber is floated to the mill in log form and remains in water outside the mill until required for conversion so that it has already undergone a certain degree of water seasoning before it is converted. The logs first pass to the breaking down saw benches whence after being broken up into convenient sized squares for further conversion they are once more shot into the small tank shown in the photo which is situated in the centre of the mill. Here they remain until required for the further stages of conversion when they are dragged up the slip ways with chains to the frame saw benches. The noticeable point here is that no timber is allowed to dry in log form, being kept in water until it is required on the saw benches.

After conversion the planks are stacked vertically as shown and remain thus for a period of 15 days after which they may be taken once more into the mill for making up into boxes but preferably, and if the supplies permit, the planks are removed to the horizontal stacks shown on the right where after being carefully



Seasoning Tank and Vertical Stacking in a Saw-mill on the West Coast.

stacked perfectly level and in such a way as to allow of full air circulation they remain for a further period of 3—6 months. By this process perfectly seasoned timber is obtained.

As regards the Bombax timber used, two varieties are recognized, one being distinctly red in colour and called "Hill" or "Red Pula" and the other being the ordinary white variety. The red variety appears to be somewhat smaller-pored and is considered much superior to the "White Pula" and care is taken to season it for the full period in both vertical and horizontal stacks. This opinion appears to receive confirmation from a note by A. Smythies on the Sissi Saw-mills of Assam which appeared in the *Indian Forester* of October 1894 in which he states that the Saw-mill Managers there distinguish between red and white Semal wood, the red Semal known locally as the male tree gives the best boxes but takes a little longer to season while the latter known as the female tree is said to possess a more open-grain and to season more quickly. I was unable to determine what this red Bombax is some opinions being that it is the timber from old mature trees and others that it is from trees grown at higher elevations. As far as its structure is concerned it is certainly smaller-pored than the common Bombax and in this respect more nearly resembles *Bombax insigne* though I gather it cannot be this species. As no definite information appears available on this point it would be interesting to have the opinion of Madras foresters and to know if the same variation in colour and quality of *Bombax malabaricum* is recognized in Assam and Burma and to what factors such variation is attributable.

'C. U. B.'

*LOPPING IN THE KUMAON CIRCLE, UNITED PROVINCES.

The object of this note is twofold :—

(*a*) To compare conditions in Kumaon and Garhwal

(*b* To put forward a constructive policy for saving the oak forests now so excessively lopped in Garhwal in defiance of the rules,—forests which are bound to disappear eventually unless this heavy lopping is stopped and the practice of lopping brought under proper control.

Conditions in the Naini Tal district.

In the Naini Tal district the oak forests are fortunate. A large proportion of the population of the hills migrate to the Bhabar taking with them everything they possess in the way of cattle. Those who have no land in the Bhabar descend to the valleys below where they put up rough winter shelters for themselves and their cattle. The oak forests are thus for the most part left in peace during the winter. One may walk from morning till evening in winter through the oak forests without coming across a single herd of cattle. The villages themselves are quite deserted with the exception of solitary caretakers who are left behind to guard the crops; these are very often old men or old women usually lame or half blind. The people return to their summer homes in March—April, reap their crops and feed their cattle on the refuse. From April till the break of the rains they may possibly, if the spring showers have failed, resort to light oak lopping. But usually the showers come and bring with them green grass for the cattle. The grass increases in quantity with the rains and so there is usually ample fodder for the village animals till the time comes round again for the people to migrate to their winter residences. Where the oak forests are heavily lopped in the Naini Tal district it will be found that the Bhotias are as a rule the culprits. These Bhotias move between Thibet and India conveying borax and wool on the backs of goats and sheep.

*A paper prepared for the Kumaun Circle Conference held at Naini Tal, on 17th September 1919.

Conditions in the Almora district.

The conditions in the southern part of the Almora district are identical with those in Naini Tal. In the middle of the district there has been in the past a certain amount of lopping. Take, for example, the Duramdupar block. This area was rapidly on the way to extinction. Reservation and protection have saved it, the people now display a decided inclination to abide by the rules which prohibit absolutely the lopping of oak. A very marked difference has taken place during the last three or four years in all the new reserves in the middle of the district, namely, since protection began. Lopping of a reckless nature, however, still continues on Bhotia tracks. In the north of the Almora district, that is to say, above the Kharbagar Sama Nachni-Bansbagar-Mawani-Dabani road, the forests though reserved are in the hands of the people; in other words, they have been put "on their honour." These people are mostly Bhotias and all of them trade. They leave their high level homes in October-November and come down to lower altitudes with their families, herds and flocks. They establish their families in winter residences where the women become busy weaving blankets and rugs while the men proceed on their peregrinations far afield in search of trade, driving along with them their sheep and goats. In spring they return to their summer residences, attend to the comforts of their families and before long they go northwards taking with them into Tibet the merchandise accumulated during the winter. They are thus nearly always on the move in search of trade and profit. The only respite their animals enjoy is when taken up to the *gwârs* (=*bughial* in Garhwal). The Bhotias with their flocks and herds spend very little time in their villages and surrounding oak forests. Whatever damage is done in the way of lopping occurs during the Bhotia's visits to his family. The outstanding fact, therefore, in the north of the Almora district is that the people are absent from their villages and oak forests for a good part of the year.

Conditions in the Garhwal district

In marked contrast to the conditions described above there are in the upper parts of the Garhwal district people who have established

themselves at high levels and who live in these villages throughout the year Examples of such places are mauzas Ramni and Ghes. The inhabitants of such places possess large herds and flocks, larger than are seen as a rule in the north of the Almora district. Their goats and sheep are often of more value to them than their land. They are more pastoral than agricultural. Their one object, since they cannot enlarge their holdings, is to increase the number of their animals. The hair and the wool obtained from the goats and sheep respectively are utilized by the people in providing themselves with blankets and clothes, surplus quantities being sold. The larger the surplus an owner can produce the larger is his income It is not only pressure of population that has driven these people to make their homes in such high localities but also a desire to trade. In the summer their herds and flocks live on the *bughiáls*; the remainder of the year they spend in the grazing lands of the village and the neighbouring oak forests. They are chiefly dependent on the forests and have, in consequence, concessions to lop oak and other species, subject, of course, to the rules of lopping, which at present they openly defy. This defiance is specially conspicuous during heavy falls of snow when, owing to their animals being temporarily deprived of shrubs, herbs and grass, the owners recklessly hack every oak tree within a convenient radius, stripping it of every leaf and leaving but a naked stem. They are far too indolent and indifferent to distribute their attention over the whole forest and adhere to lopping rules. They concentrate on a certain number of trees, lop them from bottom to top and so obtain the requisite quantity of leaf fodder. They could obtain the same quantity by exerting themselves and lopping a larger number of trees according to lopping rules. They all know the rules perfectly well. I have questioned them and have always been given the right answer about the rule admitting of lopping only the lower two-thirds of a tree. This rule it may be mentioned, has now been in existence for about 20 years There is, therefore, no excuse for ignorance even if such was displayed. In the Almora district the lopping now resembles a nibbling at the forest, but in Garhwal, as in the vicinity of Ramni, the

forests present a scene of great devastation, and are, under existing conditions, on their way to certain extinction. When once these pastoral villages exterminate their oak forest they will no longer be able to maintain their flocks and herds, and with the disappearance of the latter their prosperity will cease. The whole village will be bound to move from the site of desolation, for it will no longer be able to feed its animals in that vicinity. Instances are not wanting in Garhwal where it is easily possible to trace how the oak forests are receding from the villages. In the neighbourhood of the houses the forest has completely disappeared, a little further away the last traces of a forest are discernible further on we see the strip of oak now being heavily lopped and beyond that the untouched forest - untouched only on account of its remoteness—witnessing the destruction which is to be its own fate later on. And all this is taking place for the want of adherence to lopping rules. The propensity of the Garhwali to destroy his oak forests is certainly greater than that of the Kumaoni. The latter is more amenable to forest discipline than the former. He understands the value of forests more than the Garhwali does. The damage in the Kumaon forests is largely the work of Bhotias. The Garhwali, as a rule, sees as far as the present generation and no further. He has not got the same foresight as the Kumaoni. You may reprimand him severely on the spot, pointing at the same time to the excessively lopped trees, but the answer you will receive, with a suitable gesture thrown in, is "You may cut my throat, but I shall continue lopping the forest as hitherto.' This reply is given even by men who have served in the Garhwali battalions. In Kumaon, since reservation was introduced, lopping is confined here and there to single or small groups of trees but in Garhwal thousands of trees over hundreds of acres of forest are still grossly maltreated. Nobody knows better than the Garhwali Forest Guard the failing of his own countryman. He will even ask at times, in his own interests more than those of Government, to be posted to a beat in oak forests. I have had the request made to me. I have, in consequence, raised the security to be furnished by Forest Guards from Rs. 50 to Rs. 100.

If we are to preserve the prosperity of the Garhwali village so dependent on oak forests, it is clear that we must lay down a constructive policy. This has already been done in Almora, witness the following passage from the Forest Settlement Report:—

A constructive policy wanted

"The fact is that the oak of most of the district has suffered so severely from reckless lopping for fodder and manure in the past that there is little now left except old gnarled trees, and coppiced oak scrub, for this, I admit, the Bhotias are partly to blame, but of them later. There is practically no young stock in the oak forests of the more heavily populated tracts (Pali) of the district and the outlook is bad. I have, therefore, refused to allow any rights or concessions for the lopping of oak, on the ground that the forests will not stand it. I know that oak leaves are a fine, probably the best form of fodder; but to say that they are essential is to state what is not true." That decision is a wise one and coming generations will be thankful for it. Equally is it true of the Upper Garhwal forests that they cannot stand this continual lopping from the bottoms to the tops of trees; nor is this complete lopping of trees essential. Evidently the repeated penalties imposed on a certain number of notorious villages like Ramni, Sawar, Ghani, Wan, Kurar, etc., have had no effect. The fact probably is that the people concerned are well able to pay penalties out of the profits accruing from the hair and wool trade they indulge in. The following extract from the Garhwal Forest Settlement Report is of interest:—

"I fear that one of the most difficult tasks that lie before the department will be to bring into effect gradually the rules governing lopping, which here is done by women and children principally; and their disregard of the rules * * * * of which they are very possibly ignorant * * * * is universal."

That they are not ignorant I have satisfied myself. The difference at present between Kumaon and Garhwal, put briefly, is this: the Kumaoni must not lop at all, but the Garhwali is at liberty to lop the lower two-thirds but must leave intact the upper one-third. In practice it is less difficult to control the Kumaon

rule than the Garhwal one, for when once a man is up a tree to lop the temptation is for him to lop the whole crown. This is why the Garhwali shows such complete disregard of the rule. To him the complete lopping of a few trees means the saving of trouble in climbing a large number. There is no reason, however, why hope should be given up of teaching the Garhwali how to lop correctly. People have been taught in other parts of India. For example, about a decade ago the villagers of the Thana district in the Bombay Presidency who use teak leaves as manure for their fields, were faced with a bad outlook owing to their past excessive lopping of the teak trees standing in their *malki* (measured) land. Government stepped in and through the agency of their Revenue and Forest officials imparted instruction to the people with the result that the people now know how to lop and a manure famine has been averted. Again, in Jaunsar the people obey the lopping rules (Garhwal Forest Settlement Report, pages 17 and 18). It is most fortunate that the several species of oak so maltreated in Garhwal possess remarkable vitality ; in spite of being stripped as they are they continue to exist from between 15 to 30 years. They linger on and eventually die, what may aptly be described as a slow and painful death.

The remedial measures that suggest themselves for application are as follows :—

(a) Penalties under the Indian Forest Act.

This measure is the only one hitherto tried. Possibly it has given some results. But any application in a severer form than at present in force does not appear advisable. It should be used in conjunction with other measures.

(b) Closing heavily-lopped areas in rotation.

A definite area, say one-tenth, could be closed for a period of three years to allow the trees to recoup. No lopping at all should be permitted in such areas.

The Divisional Forest Officer would personally select such areas and close them with the approval of the Deputy Commissioner.

If necessary such areas would be fenced in with wire. This wire could be transferred from area to area.

The strip of forest near a village would be closed in first. It is quite possible this may have an excellent instructional effect.

(c) Marking off a small area of reserved oak forest nearest the village and indicating by a ring of white paint the upper one-third of each tree in the plot, permitting the lower two-thirds only to be lopped.

Such areas would be practical object-lessons to all the herdsmen in a village Though the suggestion may appear of a petty nature, nevertheless it is worth a trial which can do no harm.

(d) The grant of rewards up to Rs. 50 for adherence to lopping rules.

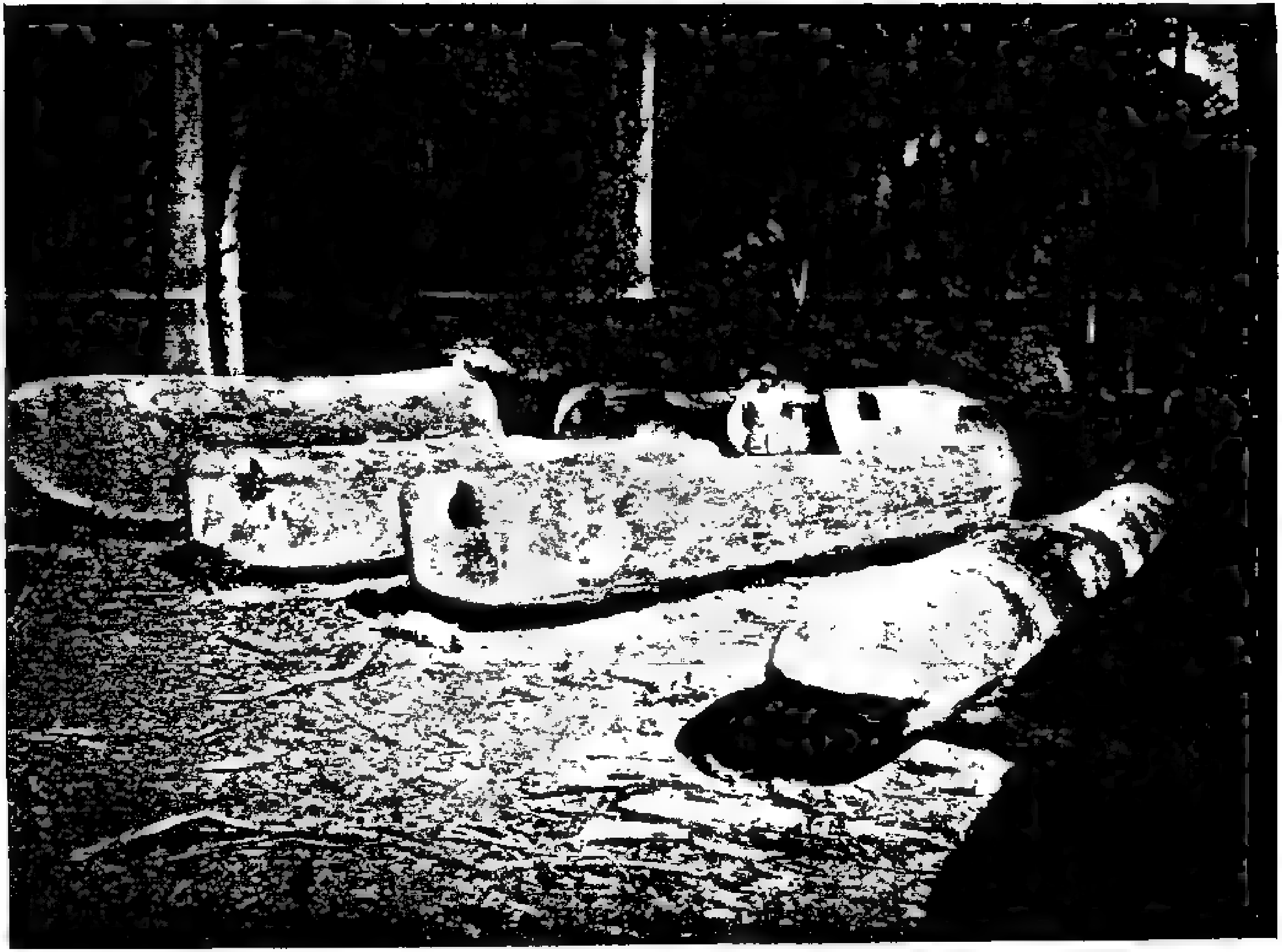
A list of villages eligible for these rewards would have to be drawn up, for example, Ramni, Ghuni, etc., etc. The reward would be paid to the whole village by the Divisional Forest Officer after a personal inspection of the forest in the neighbourhood.

The principle on which I make this suggestion is that as we have readily punished the people for violating lopping rules so ought we to be equally ready at this juncture, in order to save the oak forests, to reward them for adherence to rules. We will merely be giving back the money we have taken from them in the shape of compensation under section 67 I. F. A. In this connection is it too much to suggest that a suitable reward might also be the remission of land revenue? The period for the grant of such rewards might be ten years which would be looked upon as an instructional period.

(e) Application of rule 33 of G. O. No. 761/XIV—83, dated 8th October 1914

which runs as follows :—

"In the event of excessive damage being caused to any forest by lopping, the Commissioner of the Kumaon Division is empowered, on the representation of the Officer in charge of the



Five logs from one teak tree at South Coimbatore. The figure is leaning against log No. 2 the dimensions of which are as follows :—

Length 16' 9" Mean Girth 16' 6" Volume 285 cubic feet.

Kumaon Circle that such action is necessary, to withdraw any lopping concession either for a term of years or permanently."

I would only recommend this drastic step when all other measures had failed.

J. E. C. TURNER,
P. F. S.

BIG TEAK IN MADRAS.

During 1918 several officers reported in the *Indian Forester* the measurements of exceptionally large teak trees.

The tree giving the greatest volume of timber amongst those recorded was one from the Pyinmana Division of Burma, out of which 861·9 cubic feet of logs were obtained.

Mr. Tireman reported a teak tree from Coorg which gave 562 c. ft. and Muhammad Habibullah Sahib one from the Tekkadi Leased Forests in South Coimbatore Division from which 751 cubic feet were got.

The following figures show the outturn of a single teak tree recently felled at Palacadavu in South Coimbatore Division (see Frontispiece) : –

Log No.	Length	Mean girth.	Volume in c. feet.
1	17′	17′ 6″	325
2	16′ 9″	16′ 6″	285
3	20′	13′ 9″	236
4	15′	13′	158
5	19′ 9″	8′ 9	95
		Total ...	1,099 c. feet.

This tree was one of 111 teak trees which were felled over a surprisingly small area, considering the volume of timber obtained estimated at not more than about 150 acres. The place in question is not under any working plan. It is situated on the borders of Cochin State and there is no possible means of extracting the

timber through British territory. It so happens, however, that the head of the Cochin Steam Tramway is within dragging distance of the area, and a contractor, in the hopes of coming to terms with the Cochin Durbar for the tramming of the timber, having come forward with an offer to purchase 30,000 cubic feet of teak, 174 trees, which were estimated to give this volume, were marked for felling, since they were overmature and unlikely ever to be worked out departmentally.

The logs, many of which are far beyond the dragging capacity prescribed for any pair of Government elephants known to the writer, are being dragged by hired elephants which have no harness, but simply hold the dragging rope, made of Sterculia fibre, in the mouth.

The elephants in question—4 tuskers and a muckna—are magnificent animals and a single pair of them have dragged the biggest logs. The writer was told that Rs. 12,000 had recently been refused for the muckna.

During the measuring up of the timber it has been realized that the outturn of the trees, which are practically all as sound as a bell, was considerably underestimated at the time of marking.

Instead, therefore, of 174 trees having to be felled to obtain 30,000 cubic feet this volume has been exceeded after felling only 111 trees, when the volume of the spokes and felloes, obtained from the top ends and also sold to the contractor, is taken into account.

Below are given some figures which show at a glance the exceptional size of the trees as a whole :

No. of teak trees felled	...	111
No. of logs converted	...	210
Volume of logs alone	...	28,922 c. feet
Average volume per log	...	138 ,,
Estimated volume of spokes and felloes from top ends	...	6,314 ,,
Total volume of timber obtained	...	35,236 ,,
Average volume of timber per tree	...	317 ,,

It is interesting and very surprising to realize that if these logs alone were in some large town where they would fetch some Rs 7 per cubic foot, it would mean, at the present rate of exchange, that 111 teak trees had given logs worth £20,245, *i.e.*, £182 per tree, without taking into account the value of spokes and felloes.

A. WIMBUSH,
District Forest Officer,
South Coimbatore.

CAMP, MOUNT STUART:
Dated 28th October 1919

EXTRACTS.

THE FUTURE OF CAMPHOR PRODUCTION.

POSSIBLE EFFECT ON THE CELLULOID INDUSTRY.

Those interested in the production of camphor outside of Japanese territory (an industry that is being neglected within our Empire to a degree that we feel sure we shall regret one day, since our production of camphor is practically *nil*) as well as those who use camphor as a raw material or as the basis of their manufactured goods, should secure and carefully study a copy of the report issued by the Department of Agriculture and Commerce in Japan, for it truly shows which way the wind over there is tending to blow. Particulars given, so says the Journal of the Yokohama (Japanese) Chamber of Commerce show, that the controllers of the Camphor Monopoly are now encouraging the laying out of camphor plantations in Japan and Formosa with a view to meeting the growing demand on the international market. Before the outbreak of the war, *i.e.*, in 1914, the annual demand for camphor in Europe and United States was 9,000,000 kin. The output of camphor in Formosa and Japan up to the end of 1916 exceeded 10,000,000 kin. per annum, but it has since shown a gradual decline on account of a steady advance in the scale of wages and other causes. In 1917 the output fell to 8,000,000 kin, and it was further reduced to 5,000,000 kin. in 1918. With the outbreak of war, there arose a considerable demand for the article throughout the world, the supply of German camphor being entirely suspended. To make the situation worse, the annual output of camphor in China was reduced to something like 150.000 kin only Since the signing of the Armistice in November the Japanese agents

of the Camphor Monopoly have received many orders from Europe, America and other quarters, where the celluloid industry and other enterprises in which camphor is necessary are being developed. The Japanese Camphor Monopoly early this year, however, drew up a programme for protecting the celluloid industry in Japan, necessarily at the expense of the English, American and other markets since the aim, at least until supplies are more ample, is to curtail the shipments of camphor abroad. At the same time they are concentrating their energy on the cultivation of camphor trees in Formosa and Southern Japan for the purpose of meeting the future demands on the foreign market. If Japan sees fit to do so, why not Ceylon and elsewhere within the Empire? [*Tropical Life*, Vol. XV, No. 10, through "The Tropical Agriculturist" for January 1920.]

SALTPETRE FOR DESTROYING TREES

Where it is desired to destroy a tree without cutting it down, a hole is bored in the tree in a downward direction to the centre. For large trees an inch auger is used; for smaller ones ½ inch size is large enough. For large trees 1 oz. to 2 oz of ordinary commercial saltpetre (nitrate of potash) is used, and for smaller ones ½ oz. to 1 oz. A plug is put into the hole to keep the rain from washing it out. The nitrate of potash is carried by the sap to the tips of the branches and the rootlets. If the tree is a large one, say, 2 feet or more in diameter, very little difference will be noticed in the foliage for 2 or 3 months, then the leaves begin to fall, and it assumes a bare wintry appearance. At the end of about 6 or 8 months a little brushwood is piled around the tree and lit; it will smoulder away to the remote ends of the roots, sometimes 30 feet away from the tree, leaving masses of valuable ash; the tree will fall, and when fallen it will continue to smoulder until every particle is converted into ash.—["A Handbook of Forestry" by A. D. Webster.]

GOVERNMENT PAPER PLANT FOR NEW SOUTH WALES.

The New South Wales Government intends to undertake almost immediately experiments in the manufacture of paper from local timbers. A Committee, consisting of Mr. W. A. Gullick (Government Printer), Messrs. R. T. Baker and H. G. Smith (of the Sydney Technical College), and two other Government officers, is now arranging for the introduction of a plant into New South Wales.

This action has been taken in consequence of the satisfactory reports received from Canada of laboratory tests of the suitability of selected Australian timbers.—[*Science and Industry*, Vol. I, No. 8, December 1919.]

AUSTRALIAN SANDALWOOD OIL.

It has been found that there is a marked chemical difference between the oil derived from Western Australian sandalwood and that obtained from Indian sandalwood. The most important result of recent research was to show that the oil from the West Australian tree did not contain santalol, but a nearly related chemical compound. Medical practitioners who have used the Australian oil consider that it is quite equal to the true sandalwood oil for medicinal purposes without possessing the deleterious effects of the latter. The subject has been referred to the Institute by the Western Australian Committee with a view to having complete tests made in respect to the chemical and therapeutical properties of the oil, so that action might be taken to have the Australian product inserted in the *British Pharmacopœia*.—[*Science and Industry*, Vol. I, No. 8, December 1919.]

VOLUME XLVI NUMBER 6

INDIAN FORESTER

JUNE, 1920

THE SELF-CONTAINED FOREST ESTATE IN THE HIMALAYAS.

In these days, when forests are beginning to be recognized as one of the most important economic factors of the Empire, their administration, with a view to the supply not only of the vast commercial demands of the population by the export of timber and other commodities to the main markets, but also for the more efficient fulfilment of the requirements of the local population existing in the vicinity, has become a factor of considerable importance to the welfare of the State. It has hitherto been hampered by a want of elasticity, resulting in the constant antagonism between the interests of the forests and those of the local population. The cultivator and the grazier curse the existence of the Forest Department in which they see a malignant force curtailing their ancient freedom in the uncontrolled exercise of the practices necessary to their very existence, while the forest officer has to contend against the ignorant grazier who in the exercise of

his profession prevents the reproduction of the forests themselves and, in the long run, destroys the very factor of permanent soil fertility on which he and the cultivator alike are dependent for their livelihood.

The following note based on experience gained in other provinces embodies an attempt to evolve a practical working scheme to provide for the interests of both sides by a more economic use of the land in the Himalayas

The configuration of the country is too well known to require detailed description. Briefly it consists of vast mountain ranges intersected everywhere by valleys of enormous depth whose sides are always steep and very often precipitous. As a direct consequence, the fundamental principle determining the suitability of any agricultural crop or pastoral custom must be the *permanent* retention of those factors necessary to its *permanent* enjoyment. The pastoral—and to a lesser degree, the agricultural—customs of the country are unfortunately in direct opposition to this all-important factor of permanence. The grazier feeds his flocks in all accessible localities however steep, a practice which results in the ultimate destruction, by preventing its regeneration, of the soil-covering designed by nature to ensure that permanence, that is, of the forest,—while the cultivator who lops the trees to provide himself with manure for his fields, thus allowing the ingress of fungoid diseases, is now known to be responsible for the wholesale destruction of forests having an economic value far in excess of the field crops produced by him. On the other hand, we have the forest officer doing his best, primarily in the interests of his forests, and incidentally in those of the villager himself, striving to raise the crop best calculated to preserve the fertility of the country, but against the very existence of which the customs of the latter are in direct conflict. The divergence of these two points of view is thus sufficiently obvious, and in view of the importance of the issues arising, it is surely worth while to examine the system of forest administration, and especially of reservation, in the Punjab, with a view to ensuring a more economic use of the land combined with the better fulfilment of the needs of both sides.

Quite apart from the necessity of providing timber for the great industries of the Empire, the conservation of forest in the Himalayas sufficient to insure the permanent enjoyment of the essentials of their existence to the inhabitants is, owing to the universal prevalence of these old established rights and customs, fraught with the greatest difficulty. Hitherto the practice has been to reserve all forests in which few or no such rights exists; and in others, where the incidence of existing rights is heavier, to control them as far as circumstances will admit, and at the same time to exclude a sufficient area of forest round each village however small, to provide it with a grazing ground for its herds. To say the least of it, this arrangement involves a highly uneconomic use of the land, for in these hills, the villager can only produce a meagre crop which does not usually unaided suffice to support him, while forest land with a potential value of many times the value of the crop produced is sacrificed in the interests of the latter. To take a typical example, a village with say 20 acres of cultivation is found in the midst of a large stretch of forest. Present practice prescribes the exclusion from efficient forest management, not only of the cultivation for which land revenue of As. 4 to a maximum Rs. 2 per acre per annum is paid, but also an area of perhaps 100 acres of forest for a grazing ground, having a potential value of anything between Rs. 10 and Rs. 20 per acre per annum. Thus the existence of the two or three dozen animals owned by such a village is costing the State some Rs. 1,500 a year in each case, or in other words a very much larger area of the more valuable crop is sacrificed in the interests of a small area under an economically inferior one! As this practice is in force throughout the Himalayas from the Punjab to Assam, the economic loss to the State arising therefrom must be very considerable. The question arises, is it not possible to have both without any sacrifice at all?

In the light of more modern forest development it is demonstrable that this waste is avoidable. It is possible to supply the villager with all his requirements without the sacrifice of valuable forest in grazing grounds. The forester now regenerates his forest by closing small areas to grazing in succession, reopening

each as soon as the young trees have attained a height sufficient to preclude their destruction by cattle. At the maximum, he will not require to close more than 25 per cent. of his whole area at any one time, while in practice, the closure is frequently reduced to 10 per cent. or even less. It is also possible to grow concentrated tree-fodder crops in the areas taken up thereby actually increasing the villagers' supply in spite of the small closure to grazing necessary Indeed, it will be necessary to do this, for in any fully stocked coniferous forest, such as should be produced by intensive work, there will be little or no grazing or fodder of any sort. Again, the position as regards the local supply of forest produce to the villager will be simple. It is impossible under any system of intensive working to produce mature timber without at the same time producing large quantities of material of use to the villager, but of such low value that it will not bear the cost of export. The only fear is not that this supply which will be given free to the villager will be deficient,—but that he will fail to remove enough of it, thus obliging the Forest Department to incur expenditure in doing so. Instead, therefore, of excluding the small villages and large forest grazing grounds from the forest to be brought under management, the whole, together with the cultivation, should be included in it. The grazing ground will then be provided by the entire forest with its included fodder crop, less 25 per cent. closed for regeneration, the cultivation being demarcated off to remain as such while the village,—now included as part and parcel of the forest estate, will obtain from it, free of charge, all its domestic requirements in forest produce, in addition to supplementing its meagre field crop by its earnings in forest work. Under such a scheme the villager will ultimately form the nucleus of a technically-trained labour force destined to carry out such extremely technical forest operations as felling, sawing, planting, thinning, and so forth, and will live on the forest estate, exactly as the tea garden coolie lives on the tea estate, looking to it to provide him with all the necessities of life. Surely such an arrangement is more likely to prove conducive to amicable relations than the present one, while the economic

advantages are incontestable. If the forest officer failed to provide his employees with the means of making a prosperous and comfortable livelihood, then he may be set down as a failure in one of the most important branches of his business.

By the gradual introduction of the methods outlined above, it should be possible to build up forest estates supporting and training their own labour forces within their own confines. *Their successful development on these lines rests upon one great essential, namely the administration of such estates must be single-handed and not dual.* In other words, the forest officer must, in all matters relating to land revenue and general village administration, (excepting crime), have an absolutely free hand, and in any case, as has been shown, the land revenue of the hamlets concerned is, compared with that derived from the forests, negligible and if paid at all, would be paid by work done in the forest rather than by cash payments. This attitude is moreover perfectly logical. It is no more unreasonable for the employer of highly technical forest labour supported by the Forest Estate to insist on a free hand in the management of his employees than it is for any other class of estate holder to do so. Indeed, failure to recognize this principle, involving as it does the interference of outside subordinates, too often with their own axes to grind, will effectually damn whatever chance of success the policy advocated may eventually have. Experience in Bengal, Assam, Burma and notably in the Central Provinces, where the system of forest villages is well-established has shown conclusively that working on these lines is not only possible, but is appreciated by the villagers themselves.

The political aspect of working under such an arrangement is also of importance. When the villager finds he can live a prosperous and confortable existence within the confines of the dreaded enclosure itself, his antipathy to reservation must naturally break down. In short the underlying motive is increased co-operation between forest and village interests, which conflicting as they appear to be at first sight, are actually identical and this fact under the more elastic method of forest reservation outlined above can be,—and indeed has been,—demonstrated to that most conservative individual, the villager himself.

Very briefly the advantages of what may be termed the self contained forest estate may be summarised thus. A more economic use can be made of the land, in that a greater proportion of forest can be subjected to control sufficient to bring it to maturity than is now possible. The methods of raising forest crops in combination with field crops can be more extensively adopted than is possible under any other system. The employment of the same men on the same work year after year will make for the formation of a trained class of workmen, skilled in the various duties connected with the management of the estate on which they live and to which they look for their entire means of livelihood. Further economy in the production of concentrated tree crops yielding the fodder necessary for the local herds and at the same time preventing extensive soil erosion can be effected.

Finally, the system by means of actual practical demonstration will, if properly handled, do more to convince the villager that in these hills his own salvation lies in the proper maintenance of the soil covering designed by nature to retain its permanent productive capacity than any other under which the two interests are worked in opposition one to the other. The production of a skilled class of artisan will result in his commanding wages higher than those of the ordinary coolie. It therefore follows that the establishment of self-contained forest estate will eventually produce classes of workmen who will cease to be cultivators, who will earn more by means of their skilled labour than they can by producing poor crops in a country where the natural crop of the country is forest, and in which it will pay the forest estate to import the foodstuffs necessary to support them. Thus, in the conditions in view, the greater the area under forest, the greater the population the country will support. Therefore to exclude not only isolated patches of cultivation which happen to lie in the midst of large forests, but also still larger areas of the forest itself, results merely in the wastage of area under the main crop without any corresponding benefit. Placed in its true perspective, such cultivation is merely a minor, though

necessary adjunct to the main estate, and to place it under a different administration is unsound, makes for trouble, and tends to increase the difficulties already felt in breaking down popular prejudice to proper forest conservancy.

J. W. A. GRIEVE, I.F.S.

FORESTRY WITH THE B. E. F.

BY J. D. MAITLAND KIRWAN, I.F.S.

For the first few days after my arrival at Lyons I was kept at the Headquarters of the 11th Forestry Coy., which was near a village called Rosay. The Officers of the Coy. had no mess of their own, but were temporarily accommodated in the mess of the P. O. W. Coy. which provided the labour in that part of the forest. I had thus an opportunity of making the acquaintance of the Officers of both of the R. E. and Labour Coys. Over and over again in France amazement was expressed that I, a Forest Officer, had found my way into the Forestry Corps, because the Army Authorities, for some subtle reason, took little trouble to put men into jobs for which they were fitted by previous experience; that, at any rate, I found to be the general impression. A man was a man and nothing more, and therefore if a man was wanted for a particular job, well, anyone would do so long as he was of the correct medical category, but quite irrespective of whether he had any special knowledge of the job in hand. This being, I was told, the principle on which Officers and men were selected I was prepared to find that the personnel of the Forestry Corps (I am not here speaking of the Canadians) and of the Labour Corps was not necessarily composed of individuals who knew much about Forestry or who had any considerable experience of managing labour.

Things were not so bad as this in the Forestry Corps, however. Although there were very few of what we in India should call trained Forest Officers, yet there were a number of officers whose civil vocations bore directly on the work in hand. There were, for instance, timber merchants, engineers, and saw-mill experts, and also several land agents and foresters with a large

experience of woodlands in Britain. Among the latter I should like to mention Mr. Myles, Forester to the Duke of Westminster at Eaton, who was afterwards A. F. D. C. O. at Lyons, a sound practical forester from whom I was able to pick up many useful tips. Among the men were a sprinkling of woodmen, farmers, engineers, and the like, and altogether the personnel was perhaps as good as could be expected under the circumstances ; for it must be remembered that most of the officers and men were recruited from those who had been up the line, and who through wounds, low medical category, or for some other reason had earned a billet in the back areas. Few had, like myself, been sent out specially for Forestry work, and I never ceased regretting that I had not myself done my turn of service in the trenches. The Labour Coys. were also as a rule recruited from men who had been up the line, but in selecting the personnel for these Coys. the Army Authorities never seemed to consider that the handling of labour was a matter requiring experience. The result was that many of the men were placed in a very unfair position. They were expected to be able to distribute their labour in the most economical manner and to devise means for getting the best work out of the men, when they had, in many cases, never had a man under them in their lives before. This was a matter of considerable difficulty to the Forest Controlling staff, and was probably one of the reasons for the subsequent introduction of task work.

I spent only a few days at Rosay, and during that time I made rounds of inspection in company with another subaltern of the Coy. He was provided with a horse, and I managed to borrow one. A number of officers were provided with horses, but A. F. D. C. Os. were supposed to have a motor bike and sidecar, or a share in one, while F. D. C. Os. were supplied with a car, sometimes a Sunbeam, but more usually a Ford. The chief thing that I noticed during these inspections was the difficulty of knowing how much work it was possible for a man or a party of men to do in a day. The F. D. C. O. was continually insisting on a greater outturn of logs per diem, and the R. E. Officer was in

his turn spurring on the labour (in this case P. O. W.) to greater efforts, but neither of them seemed to be sure how much a man could really be expected to do if he worked hard, for the controlling staff was not sufficiently numerous to allow of them watching one of the many working parties continuously throughout the day. This was a real difficulty, and it was eventually solved by the introduction of task work. A committee was appointed which toured the forests and by means of enquiry and experiment, decided what amount of work could be done per man per day in coupes of every class. Schedules of task work were then drawn up and circulated to all F. D. C. Os., so that when a Labour Coy. started work in any coupe all the F. D. C. O. had to do was to inspect it, see what its nature was, and allot a task according to the schedule applicable to coupes of that particular class. It was the business of the labour officer to see that the allotted task was properly completed every day, but it was not considered finished until the quality of the work had been passed by the R. E. Officer, or one of his N C. Os. This system of task work not only made things easier for the controlling staff but was also appreciated by the labour, for tasks were so arranged that by working really hard it was possible to complete the work an hour or two before the usual time for dismissing the parties. The full working time in cases where tasks were not allotted was nine hours.

The following gives a specimen of the kind of tasks allotted:—

SCHEDULE A—FELLING AND CONVERSION *in situ*.

Saw timber coupes.—Specification.

Felling, snedding, and knotting, saw timber being left in full length, and firewood converted and stacked. All fuelwood over 6 inches diameter to be split, so that no cross measurement exceeds 6 inches. Fuel where within 50 yards of a road or ride to be stacked on roadside; M T roads to have preference. Elsewhere the fuel must be stacked where it can be picked up by the H. T. Poles, if required, to be produced where material is suitable. Saw timber will be measured in metres cube, one-fourth girth, —fuel and poles in stères.

No. of Task	Particulars	Cubic Metres per man per day.	REMARKS.
A1	Hardwood Final, Secondary, and heavy seeding—felling coupes	3	If cross-cutting of saw timber is included in task the above tasks will be reduced by 0·5 metres where the timber is required in lengths over 10 feet, and by 0·75 metres when in lengths of 10 feet or less. In such cases the tasks will be referred to as A1c, A2c, etc.
A2	Hardwood Light seeding—felling coupes	2·75	
A3	Hardwood Standards in coppice	2·75	
A4	Pine coupes containing heavy timber with few poles	3·5	

According to the above table, if 200 men were working in a final felling coupe in Beech forest they had to fell and convert to the required specification 600 cubic metres of timber (or about 21,190 cubic feet) except in cases where the task included the cross-cutting of the logs, when it was reduced by the proportions given in the remarks column. (The logs were not as a rule cross-cut until shortly before they were wanted at the mill, as we were never sure of what lengths would be required.) As soon as the 600 cubic metres had been produced the working party was allowed to leave, but the logs, whether cross-cut or not, had to be properly trimmed and in a fit condition for the saw bench before they were measured, and the firewood split and stacked according to specification. The number of poles of the different classes to the stère, or stacked cubic metre, was known, and there was therefore no difficulty in totalling up the number of metres of the various classes of timber which had been produced.

In addition to the above table there were various other schedules governing task work. In the case of coppice coupes, for instance, if it was a case of felling only, each man was given an area of 200 square yards; if on the other hand the material had to be both felled and converted into, say, fuel, poles, and pickets, the brushwood being left neatly piled and the stumps being properly dressed, 2 cubic metres per man per day was found to be a suitable task.

Of course the temptation in task work was to sacrifice quality for the sake of quantity, and the R. E. Officer had to keep a sharp look-out for defective work. As soon as the labour understood that careless work would not be passed they took pains to turn out stuff of the proper quality; any slackening in supervision was, however, fatal. The O. C. of the Labour Coy. was responsible for determining when the task was finished and for dismissing his parties. It was the duty of the F. D C. O., or his respresentative on the ground, to call the attention of the Labour Officer to any discrepancies in the measurements or to any irregularities in the nature or quality of the work, and the latter was bound to give any such representations his immediate attention.

After being a few days at Rosay I was transferred to what was known as the "Indian camp," so called because in that part of the forest the labour was furnished by a Company of Lushai Indians. The O. C. was, I think, a tea planter, and had himself brought the Coy. from India. There were at first only two subalterns, one a Bombay Burma Trading Coy. man, and the other a former N.-C. O. in the Supply and Transport Corps. I was very glad to be with Indians again, but I felt exceedingly sorry for them. The camp was at that time in a very uncomfortable state. Huts had not yet been provided, although they subsequently were, and so badly drained was the site that, as rain was of daily occurrence, the whole place rapidly became a sea of mud, and even to walk from tent to tent was like struggling through a morass. The weather was typical November weather and bitterly cold, not a healthy dry cold, but that damp penetrating variety which seems to be a speciality of "Sunny France," and the Lushais felt it very much. I wondered they did not die, and some of them may have done so subsequently for all I know, but they were plucky little fellows, and the way they stuck it out was admirable. Officers usually contrive to make their mess pretty comfortable, however adverse the conditions, but anything more depressing than the mess in this camp I have rarely seen. The mess house was a tattered looking marquee pitched on the muddy ground, with no floor board or durrie of any kind, and

the furniture consisted of a long table and three or four desperately uncomfortable wooden chairs. The army rations were as a rule nothing to grumble about, but the mess cook in this case must in civil life have been anything except a cook, possibly a dentist or some other kind of misanthrope, for he served up the most abominable dishes that it has ever been my lot to taste. After dinner, or rather after a meal served about the same time that other more fortunate people were eating dinner, we used to sit huddled up in coats cowering over a charcoal brazier, sometimes trying to read by the flickering light of an Army candle stuck in a bottle, our only source of illumination, and sometimes talking over the day's work and discussing the programme for the morrow.

My duties were to keep the Labour Officers up to the mark, to see that the quality of the material produced was up to specification, and generally to supervise the work. The Officers in this company were keen on their work and there was no trouble about the labour, so all that it was necessary for me to do was to direct their energies into the proper channels. As they had hitherto been working on their own without any R. E. control, with the exception of the general control of the F. D. C. O., I fancy that I was not at first very welcome. However we soon settled down on friendly terms, but I was not there long enough to get a proper hold of the work. The ordinary felling and conversion operations as well as the manufacture of charcoal were in progress, but there was nothing deserving of any special comment, and I will say no more about this camp with the exception of a few words about the work of the Indians. Opinions seemed to differ as to their merits as workmen. Their labour was criticised by some Officers as being uneconomical on the ground that more men were required for doing a single job of work than was the case with white labour. It was true that when, for instance, four white men would carry a log a certain distance ten or a dozen Lushais would tackle the same job, and yet the comparison was hardly fair. The Indians seemed to work like ants, a large number of them going at a

job together, getting it done, and then tackling another, and the only true test was a comparison of outturn. I cannot remember exactly what their daily outturn was, but I know that it compared quite favourably with that of other companies. They were a hard-working, patient, and uncomplaining lot of men, and considering that they were working in an inhospitable climate, thousands of miles from home, I think they have every reason to be proud of the way in which they helped the Empire during the Great War.

After being a fortnight or so at the Indian camp I was transferred to a P. O. W. camp. The mess there was in a little wooden hut, and far more comfortable in every way than that of the previous camp. The huts for the officers' quarters had, however, not yet arrived, and as I sat in my leaky tent, trying in vain to dodge the drip, I used to listen to the German prisoners playing the piano in their warm and comfortable huts, and wonder whether in prison camps in Germany our men were housed in conditions of such comparative luxury while the German Officers shivered in tents. I also wondered why, if wooden huts were available, the Indians were not supplied with them before the Germans.

I was only at this camp for a week or two, and there was nothing in the work which calls for special comment. In the case of this camp also I was the first R. E. Officer to be placed in immediate control, and as there was a good deal to put right I was not welcomed with any great heartiness. Besides the somewhat uncongenial atmosphere the only thing which made my stay at this camp memorable to me was that for the first time I had to deal with German labour. I little thought when I was studying forestry at Lyons some eighteen years previously that I should one day be exploiting the forest myself, and using German prisoner labour for the purpose! As a large proportion of our forest work in France was done through the agency of P. O. W. labour, it will be convenient here to record my impressions of it.

The Germans were employed on all classes of work—the ordinary exploitation, saw-milling, road work, etc., and the great

drawback to this class of labour was that the prisoners were not allowed to work unless they were properly guarded. Each Company had its own Escort, the strength of which I forget, but what I do not forget is that they usually seemed to be under strength. Escort had to be supplied in the proportion of one guard to every ten prisoners, and the result was that it was often impossible to have as many working parties as was desirable owing to the insufficiency of escort available. It was probably more difficult to guard the prisoners properly in forest work than in the case of any other class of work, and I have no doubt that they could have escaped without much trouble whenever they wanted to. Some did in fact escape from time to time, but they did not as a rule get far, and the fact is that there was very little inducement for a prisoner to escape. They were as a rule very well treated and were generally as contented as it is possible for prisoners to be. If they escaped they would have to wander about for weeks in a hostile country, living as best they could, and with very little chance of eventually getting through the lines. The men really to be pitied were not the prisoners but the N.-C. Os. and men of the Escort. The latter were generally of low medical category and therefore supposed to be unfit for the strenuous work of the front line, where most of them had of course originally been. I can, however, imagine no more fatiguing or distasteful work than standing on guard in the coupes day after day, often in drenching rain or in deep snow, watching the prisoners' work, and I fancy that no men longed more fervently for the end of the war than they did.

Generally speaking the Germans were very good workmen if they were kept up to the mark. If not properly looked after however they were very slow, and anything slower than their marching to and from work I have never seen. Their N.-C. Os. were as a rule very good, and were of great assistance in organising the work, and they were given a certain amount of reponsibility in this connection. Many of them seemed quite willing to co-operate with us in getting the best results, and they usually had their men well in hand. The introduction of task work was attended with excellent results as far as P. O. W. labour was

concerned, as it speeded the work up in a wonderful way and gave them that incentive to work hard which had before been lacking. In their eagerness to get their task done as early as possible some of them became adepts at faking the work, and great care had to be exercised in checking the measurements and the quality of the outturn. A favourite trick was to stack firewood so loosely that the inside of the stack was practically hollow, although it looked all right from the outside, while another dodge was to fell trees close at hand, which had not been marked for felling, in preference to looking for those which were so marked, and which in the case of some coupes were rather scattered.

I remember having to investigate a case of this kind when I was working in Forêt d'Eu. The coupe in question was in pole forest where a thinning had been marked, the trees not having been numbered or hammered but simply grooved with a scribe. The Germans, either to save themselves trouble or perhaps out of pure mischief, had felled any trees which took their fancy quite irrespective of whether they were marked or not, and somehow or other they had managed to get hold of a scribe, and, with a view to concealing the fraud, had marked a number of trees as they lay on the ground. They had not been clever enough, however, for not only had they not marked all the trees thus, but those they had marked were in many cases marked so far from the base of the stem as to give the show away entirely, for no one except a giant could possibly have reached so high when the trees were still standing. The French were not pleased, as may be imagined, when the Germans made illicit fellings of this kind.

The prisoners complained sometimes that the task set them was too hard, but when once they saw that there was no weakening on the part of the authorities they always managed to get it done with plenty of time to spare. We had a little trouble in this way in one of the forests to which I was posted. There had been a number of air raids in the neighbourhood, and some of the enemy aeroplanes had been shot down and their crews taken prisoner. In one of these planes were an Officer and a corporal, and for some reason or other the Officer, as was afterwards discovered, had

changed clothes with his corporal. This man, a corporal in appearance but in reality an officer, was sent to a P. O. W. camp in this particular forest, and being an Officer he soon got an influence over the men and tried to cause trouble. One day the men all refused to complete their task, saying that it was impossible for them to finish it within the allotted time I therefore went to the O. C. and discussed matters with him, the result being that he kept the men in the forest until about 9 P.M., standing them to attention all the time, and after that there was no more trouble about their task.

As a rule, however, the men were pretty contented. We were putting up a new saw-mill at Crècy once, and as a party of Germans were unloading a crane from a truck something went wrong, and the truck upset killing one of the party instantly. He was given a proper funeral, and the O. C. allowed several of his friends to attend it, an action which evidently touched them; for afterwards their Sergeant-Major came up and said he wished to thank the O. C. on behalf of the men not only for his kindness on that particular occasion, but for the way in which they had been treated all along, and he added that they were glad that it was the British Army that had captured them. On the O. C. reminding him that the treatment meted out to our men in Germany was very different, he expressed his sorrow for this, and said that when all the German prisoners eventually returned home they would impress on their people how well the British had treated them. It would be interesting to know how this promise has been kept.

After I had been 10 days or so at the P. O. W. camp, I was put in orders as A. F. D. C. O., Lyons Forest, but I never took up the appointment, for I received telephonic instructions to proceed to Crècy Forest as A. F. D. C. O. on the following day. Before speaking of Crècy, however, it may be well to give a few notes on the Sylvicultural management of the Forêt de Lyons.

As a Forest Officer I was of course interested in finding out as much as I could about the management of the forests in which I was stationed, but I was always confronted by two difficulties: firstly the working plans in France are in manuscript, and

therefore I could not get hold of a printed copy to study, and, secondly, the French forest staff with whom I came in contact often did not know much about the details of management themselves. The latter statement may seem a curious one but the fact is that the members of the Forest Service of military age were mobilized like everyone else at the outbreak of war, and after they had seen their share of the fighting they were posted to charges in various forests for, I suppose, the duration of the war. In many cases these charges were in forests very remote from those in which they had previously been serving, and as their duties were, in the case at any rate of the forests in which we were interested, to supervise the exploitation which was being carried out by the British Army they did not of course trouble much about the details of the ordinary management. The Conservators and Inspecteurs were over military age, and as a rule I fancy they retained their peace time charges during the war, but as a Second-Lieutenant I was not brought much in contact with such high officials, and the officers I saw most of were those who had been appointed Liaison Officers. And here I should like to pay a tribute to the French Forest Officers. A more charming and courteous set of men it would be impossible to find. As I have pointed out in a previous article, it must have been a great trial to them to see their forests being hacked about by untrained labour, and yet they were almost invariably reasonable, considerate, and good tempered, even though on occasions, as I shall show later, they felt it necessary to make repeated complaints about the way in which the work was being carried out.

As regards the management of the Forêt de Lyons I was fortunate enough to see the Inspecteur, whose headquarters are in the forest, and he very kindly gave me some notes on the subject.

It is a typical beech forest, although the beech only form 54 per cent. of the crop, 25 per cent. being hornbeam, 18 per cent. oak, and 3 per cent. ash and soft woods. The forest records seem to go back for at least 400 years, for although the area is now about 26,000 acres it seems originally to have been much

greater, and to have been reduced by a tremendous fire in the year 1519. The forest came under systematic management under the control of a proper staff in the year 1669, and was managed under the "Tir and Aire" system and modifications of that system until the year 1856, when the Shelterwood Compartment system or as we call it in India the "Uniform Method," was introduced, and that method is still in force.

The area is divided into 15 felling series, each series being worked under a rotation of 180 years with a regeneration period of 30 years, there being thus six periodic blocks in each series. Prior to 1905 the rotation was 150 and the regeneration period 25 years, but the latter having been found too short the rotation and period were lengthened, the number of periodic blocks remaining the same.

Thinnings are made every ten years in all periodic blocks except the one under regeneration, and they thus pass through each compartment three times during the period. The annual yield is fixed by volume, and is prescribed for a period of ten years. Enumerations are made in the periodic block, in each series under regeneration and the volume worked out, increment being disregarded; and to this volume is added the volume, if any, remaining over on account of trees not yet felled in the block which was previously under regeneration. Thinnings are of course carried out by area, but the volumes of the thinnings are estimated. The annual yield over the whole forest for the years immediately preceding the war was, in round numbers, 1,660,000 cubic feet, of which 988,000 cubic feet were to be realized from regeneration fellings and 672,000 from thinnings, etc. The net revenue came to about 14 shillings per acre per annum.

We were exploiting coupes of all classes and in areas where secondary and final fellings were in progress great precautions were of course necessary to reduce to a minimum the damage to regeneration. Transport was restricted to certain fixed paths, horses working in the coupes had to be muzzled, and so on, and although complaints were occasionally made by the French, I think that on the whole work was well and carefully done.

In order to get to Crècy I had to pass through Rouen, and I there met for the first time my Chief, Colonel Oldham, Deputy Director of Forestry in charge of the L. of C. Forestry Group Colonel Oldham was a regular R. E. Officer, and was serving on the Indian establishment at the outbreak of war; he was much liked and respected by his subordinates in France. After giving me certain instructions about the work at Crècy, he sent me there by car, a run of some 90 miles. Crècy, which is situated about 15 miles north of Abbeville, is an interesting place as having been the scene of the historic battle where cannon were used for the first time. The hill on which formerly stood the windmill from which the King of England watched the Black Prince win his spurs is still plainly visible, and the mill itself has only recently been dismantled From this eminence a fine view of the battlefield was obtainable, and on it there was a very old monument marking the spot where the old blind King of Bohemia was killed. It bore an inscription in old French recording the last words of the King, which were to the effect that he called on someone to lead him on to the battlefield that he might strike one more blow for his country. We used to picture the poor old gentleman being guided into the thick of the fight by his somewhat nervous batman and being placed in such a position that he could get a whack at the enemy. Sad to say, however, the other fellow seems to have got his blow in first, and hence the monument.

The F. D. C. O. at Crècy was Captain (afterwards Major) Hellmuth, of the Canadian Forces, and he had with him a Canadian Forestry Company, of which he was O. C. He did not, nor did his company at that time, belong to the Canadian Forestry Corps, and the position was a somewhat peculiar one. Major Hellmuth came out early in the war in charge of some remounts, and when his remount camp was broken up he was asked to form a company for forest exploitation. This was prior to the formation of the Forestry Directorate and before the arrival of the Canadian Forestry Corps in France.

He agreed to do so, and carefully selected his men, and I believe Major Hellmuth claims that it was the success which

attended their efforts which led the authorities to consider the project of raising a regular Forestry Corps from Canada. Major Hellmuth and his Company came under the authority of the Forestry Directorate as soon as it was constituted, and for a long time preferred remaining with the Imperials to joining the Canadian Forestry Corps, and this was the position of affairs when I arrived at Crècy. Major Hellmuth combined in himself the duties of F. D. C. O. and O. C. Coy., and the men of his Coy. ran the saw-mill and supervised all the forest work. The personnel of the Company had somewhat changed since its first formation, but it still contained a number of the original men, and a capital lot of fellows they were. A somewhat unconventional crowd, and marked by a sturdy independence of character, they were not afraid of expressing their opinion, and they might have broken the heart of an officer accustomed to judge the merits of a soldier chiefly from the smartness of his salutes or the brightness of his buttons. In the things that really mattered, however, they excelled, and for handiness in all matters relating to woodcraft, engineering, the management of horses, and the like, they were hard to beat. A more loyal or hardworking lot of men I have never met, and it is with feelings of pride and pleasure that I look back on my association with them for a period of seven months.

(To be continued.)

NATURAL REPRODUCTION OF SAL IN SINGHBHUM.

The Singhbhum and Porahat Forest Divisions both in the Singhbhum District of Chota Nagpore (Bihar and Orissa) possess some of the finest sal in India and sound trees up to 12′ girth and 150′ high are not uncommon (Fig. 1).

The best forests have been worked according to the selection *cum* improvement method. Chiefly for economic reasons it has been decided to replace it by a system of concentrated regeneration fellings by periods, local forest officers are now faced with the problem of regenerating a given area in a given time. Though the intention is to limit the fellings as far as possible to areas

Fig 1. Virgin Sal forest. Trees 8 to 10 feet.

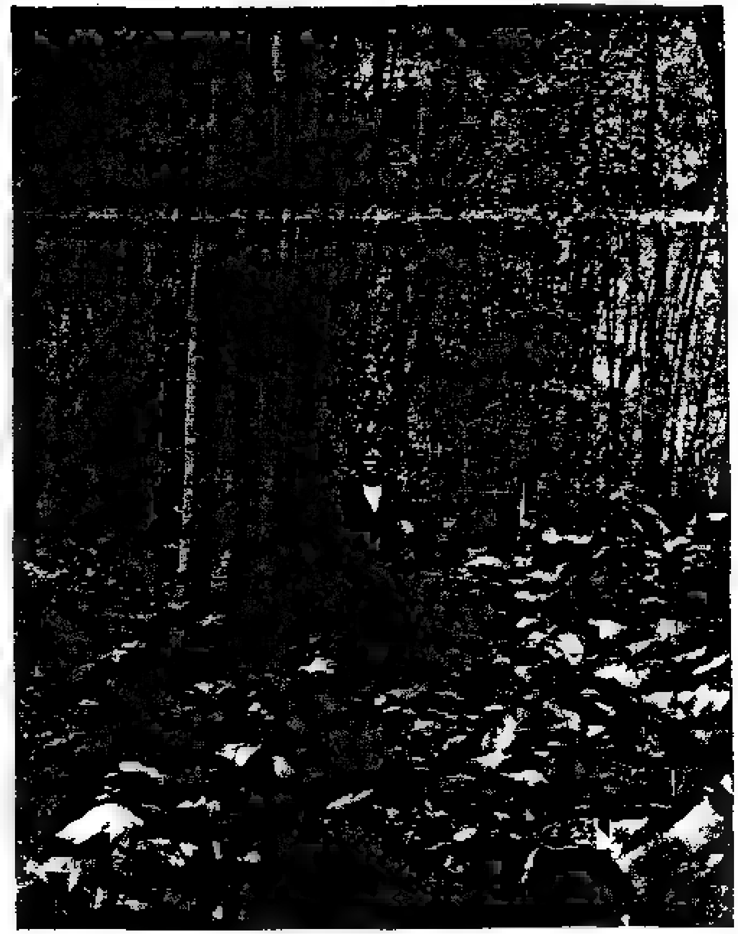


Fig 2. Reproduction under heavy shade of bamboos.

where there is plenty of established regeneration, this will not always be possible and large areas will have to be regenerated where at present sal seedlings are absent or scarce. Under pressure of this problem these few notes have been collected in the Porahat Division as a guide to further investigations and because no collected account of the factors governing the natural regeneration of the Singhbhum Forests appears to be on record.

The principal adverse factor in the growth of sal seedlings in Singhbhum is drought. The annual rainfall averages about 55 inches, nearly all of which falls in the period from June to September. Even in this period breaks of dry weather up to three weeks in duration are not uncommon. Occasionally a few showers fall in the cold weather but they can never be relied upon. Violent "nor'westers" are a common feature of the hot weather evenings often not accompanied by rain. Thus the sal has to endure a period of eight months during which the rainfall is scanty and capricious In April and May the heat becomes intense sometimes reaching 115° in the shade.

The surface of the country is cut up by numerous hill ranges rising to 2,800 feet with water-courses and ravines flowing in all directions. Every aspect is represented.

In view of these conditions it is not surprising that good sal is found on less than 20 per cent. of the total area of forest and is mainly confined to valleys which contain water all the year round, to northern and western aspects of moderate gradient and to sheltered hollows, ledges, or saddles in the hills. Almost without exception on southern aspects exposed to the full force of the sun, sal is of very stunted and inferior growth or absent altogether, being replaced by *Anogeissus latifolia*, *Sterculia urens*, *Odina Wodier*, *Nyctanthes Arbor tristis*, *Euphorbias* and *Gardenias*.

During the cold weather months there is a heavy deposition of dew which dries up rapidly on exposed aspect but is retained till mid-day in sheltered localities Dew is heaviest in places where there is no overhead cover such as sheltered fire-lines and open jhumed lands on northern slopes. The amount of deposition of dew and its rate of evaporation probably have an important

influence on sal reproduction. Retention of dew appears to be one of the reasons why, other things being equal, aspects sheltered from the morning sun generally show the best regeneration. Every advantage ought to be taken of this important factor in future regenerative operations and with this object experimental plots have been laid out to test the effect of clear felling in strips against the morning sun. Frost is practically unknown.

Connected with the factor of drought is the habit local sal seedlings have of establishing themselves and growing to a considerable height under very heavy shade (Fig. 2). In certain localities cleanings have revealed a surprising quantity of sal seedlings in every stage of development. In this and all other localities where a similar state of affairs was noticed the soil appeared to be well-drained and generally on a slope.

Sometimes in flat low-lying localities sal regeneration is absent though there may be a deep fertile soil and a healthy well stocked sal over-wood. In fact it has often been remarked that young sal is generally absent under large trees of its own species. The cause is not properly understood. It is not due to excessive shade because as already mentioned sal can establish itself under heavy shade and there is often plenty of light under a tall over-wood of sal Mr. Haines has suggested drip as a possible explanation. The heavy leaf-fall from large sal trees may effect it owing to the mechanical obstruction to germination offered by undecomposed leaves. Roots of seedlings assume the most extraordinary shapes in their efforts to penetrate a layer of leaves.

Occasionally sal appears to be ousted from moist and fertile valleys by Asan (*Terminalia tomentosa*), Jamun, Simul and other miscellaneous species (see Fig. 3). It is never entirely absent in such places and what there is of it is always of good quality. Apparently the only reason why it is not gregarious here is the exceptionally favourable conditions for tree-growth which give other valley-loving species a chance of competing with sal on equal terms. There is no evidence for the assertion that its absence is due to insufficient drainage. There ought to be no

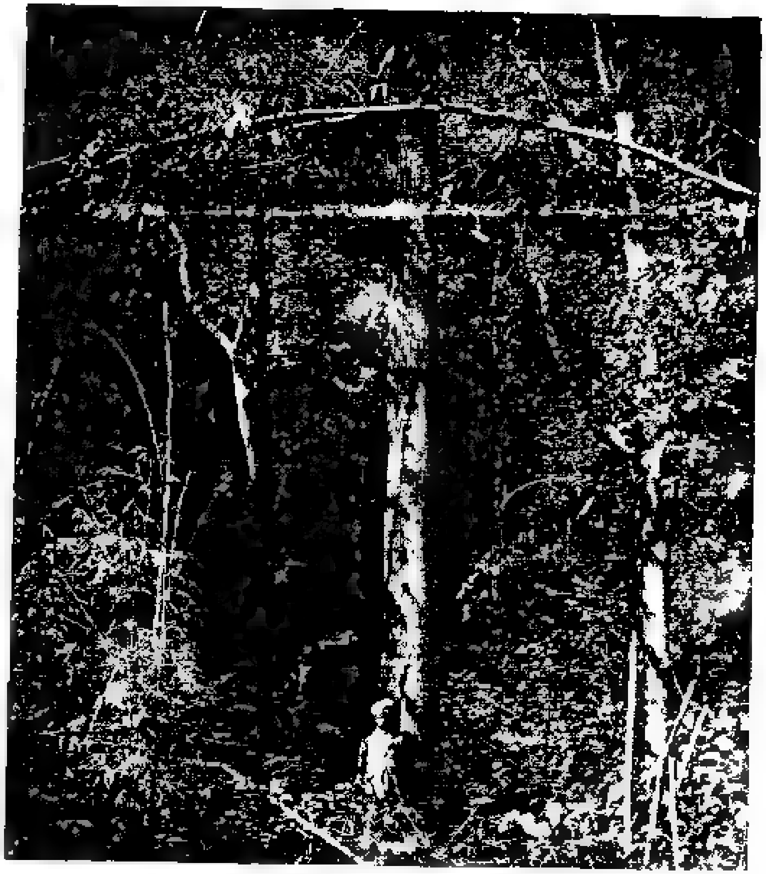


Fig 3. Miscellaneous forest in a moist valley. The large tree in the centre is *Terminalia tomentosa*.

Fig. 4. Undergrowth of *Imperata arundinacea* in a clearing.

difficulty in completely stocking these areas with sal during cultural operations following regeneration fellings.

An attempt had been made to study the effect of different species of miscellaneous undergrowth on sal regeneration. Weeds comprise seedlings of the climbers *Bauhinia Vahlii*, *Millettia auriculata*, *Spatholobus Roxburghii*, *Smilax macrophylla* and occasionally, near the boundaries, *Combretum decandrum*; the woody undershrubs *Flemingia Chappar*, *Nyctanthes Arbor-tristis*, *Strobilanthes auriculatus* and *Clerodendron infortunatum*; and the grasses *Heteropogon contortus* (Spear grass) and *Imperata arundinacea*. *Ischæmum angustifolium* (Sabai grass), though very common, is rarely found with sal regeneration being confined to the driest and most exposed localities

It has been noticed that where climbers form a large part of the undergrowth established sal seedlings are usually scarce, though this is by no means always the case. These climbers have been seen twining round saplings and bending them nearly double by their weight Vigorous cleanings appear to be the only way to save the regeneration in such cases *Millettia* undergrowth is often seen occupying the ground to the exclusion of sal.

Sal seedlings in all stages of development are usually found in abundance under *Flemingia Chappar* and push their way through very successfully. *Flemingia* appears to be a good nurse for sal. Its whippy stems offer very little mechanical obstruction and its semi-transparent yellowish leaves allow light to get to the seedlings at the same time protecting the soil from too rapid evaporation.

Clerodendron is generally found in shade, and usually on moist localities. In deep shady valleys it grows to a height of twelve feet forming an impenetrable undergrowth. Owing to the extremely heavy shade given by its large leaves and its dense habit of growth, *Clerodendron* is undoubtedly inimical to young sal.

The grasses *Imperata arundinacea* and *Heteropogon contortus* come up in great profusion whenever a heavy opening is made in the canopy (Fig. 4). These grasses have always been considered a nuisance but careful examination generally reveals a large quantity

of seedlings. Obviously dense masses of grass must prevent a good deal of seed reaching the soil but once it has done so the grass appears to offer no further obstruction and in fact acts as a nurse. Cutting and burning the grass before a seed fall will obviously enable a much larger quantity of seed to reach the ground. The area shown in figure 4 was treated in this way with the results shown in figure 5. Soil wounding was done over half the area and the results were even better. Local experience shows if done at the end of the rains uprooting is unnecessary apart from its being very expensive. Cutting or coppicing level with the ground ought to be sufficient. The recuperative power of all vegetation appears to be very low at the end of the rains probably because of exhaustion after the season of most vigorous growth. Several observers have remarked that stools of all species coppiced in the rains take a long time to send out shoots and sometimes do not reproduce at all. Even those shoots that do appear are weak. Advantage might well be taken of this fact to do cleaning and weeding as far as possible towards the end of the rains. Figure 6 shows an area where the dense mass of weeds and climbers was cut flush with the ground in September and appeared to have made practically no progress up to the time the photograph was taken in November. The ground is covered with first year sal seedlings which have not yet died back. The retention of the overhead cover is of course important until the seedlings become established, and had there been any *Flemingia* on the ground it would have been kept as a nurse. It remains to be seen what will happen during the hot weather and ensuing rains.

It is impossible to draw up any definite conclusions or to frame precise rules for the conduct of regeneration fellings and subsequent cultural operations until observations and experiments have gone a good deal further. Local Forest Officers are now devoting a good deal of their time to the subject of regeneration and it may be possible to publish some interesting conclusions at the end of another working season.

F. K. MAKINS,
I. F. S.

March 1920.

Fig 5. Result of regenerating grassy area by burning and soil wounding and weeding in the rains.

Fig 6. Result of vigorous cleaning in September. Seedlings abundant.

NOTE ON SAL SOWINGS IN THE WESTERN DOOARS.

Before describing the experiments which have taken place in the artificial re-stocking of sal forests it is desirable for the benefit of the general reader to give a brief description of the country and the forests.

The forests are found on pure alluvium consisting of sand and loam in varying proportion which has been brought down by numerous streams from the Bhutan Himalayas. The land is consequently extremely flat, occasional ridges marking the sites of old river banks and it is on these ridges that sal is mainly found. There is a slight but imperceptible slope from the north in a southerly direction. There are fairly large depressions which become more conspicuous during the rains when they get flooded owing to the flatness of the country and the time it takes for the rain-water to run off. There is no frost and rainfall is heavy being upwards of 160 inches.

These forests thirty years ago were exposed to frequent fires which kept down evergreen forest so that there were blocks of sal forest often very extensive, separated by grass savannahs, the mixed forest being confined to river beds and banks of streams. The result of successful fire protection during about a quarter of a century has brought about the gradual disappearance of the savannah land and its replacement by mixed forest. The sal forest has shown little or no sign of extension and generally speaking occupies the higher levels. Sal is, however, also found on hummocks in swampy areas which may be due to the big Assam earthquake of 1897 causing a lowering of the ground in places and a general raising of the under water-level or the clearing of large tracts of forest for tea plantation causing a rapid run off of water from the higher ground A very large number of dead sal trees of all sizes have been exported from these forests.

A mixture of evergreen species has also invaded the sal forest in which sal regeneration is conspicuous by its absence

and the problem which faces the Forest Department is how to re-stock the forest with sal before the present crop is ripe for the axe.

Experiments in the artificial re-stocking of grass savannahs were begun nearly twenty years ago at a time when there was still a good deal of reproduction to be found in the sal areas not at that time invaded by evergreen jungle. These experiments owing to other more important work, changes of officers, etc., were not followed up very methodically. Land was cultivated by forest villages, sown up with sal and subsequently invaded by Mallata (*Macaranga* sp.) which was in some cases deliberately introduced as a foster-mother and in order to kill out the grass which owing to the forest fires was then looked upon as a bugbear. The writer was unable to visit these particular areas, but was given to understand that quite a number of sal poles have come through which are now promising though they have been kept back and suppressed for some years by the Mallata. Owing to delay thus caused Mallata, though a good grass killer, is not satisfactory as a foster-mother. It may be noted that this species will catch up and overtop sal even if the latter has had several years' start. It rarely attains 50 feet in height and its crown tends to thin out considerably allowing sal to come through in course of time.

Sowings of sal made under the cover of mixed forest in 1911 and 1912 were an absolute failure and showed conclusively that sowings must be done in the open. In 1913 sal was sown on a small scale on ridges 6 feet apart in open grassland formerly under cultivation. A great deal of trouble was taken with frequent and extensive weedings. The results now are, however, very good, though there is still some grass on the area and a fire would cause considerable damage.

In 1914 to reduce the cost, mounds at intervals of 10' × 10' were constructed and in 1915 similar but smaller mounds were made on which sal seed was sown. These all proved a failure owing, curiously enough, to the prejudice of wild pigs which destroyed the mounds wholesale. Rats also invaded the mounds

presumably finding them useful as shelter when the land got inundated during heavy rain.

In 1916 in two instances sal was sown in a cultivated area *after* removal of the field crop. This, however, did not give the sal a sufficient start over the grass and did not give such good results as later sowings.

In 1916 and 1917 sal was sown in taungyas thick in lines six feet apart. Sal seed is available after the cotton has sprouted and it is then sown in a mixed crop consisting mainly of upland paddy and cotton. The field crops are sown direct on the burnt land without any ploughing or hoeing. The villagers keep their own crops and incidentally the sal seedlings thoroughly weeded.

In 1918 similar sowings were made in fresh areas but in some of the areas sown in 1917 cotton was again sown and kept weeded throughout the rains of 1918. In one case where the grass was very thick and the area had been under grass originally, cotton was not resown but the area was hoed up like a tea-garden with fair but not such good results.

In 1919 sal was sown in thullies 6′ × 6′. This was mainly due to the fact that there was a great scarcity of sal seed that year and an early drought which spoilt the first sowings. This is not so good as the sowings in lines.

It is difficult to forecast the result of these comparatively recent sowings but the most promising are those in which cotton has been cultivated for a *second year* on fairly high ground which was formerly under forest and not savannah land. Generally speaking it is now held to be inadvisable to undertake sal sowings on land which was originally grassland or in low-lying localities owing to want of drainage.

It is axiomatic that the more field crops taken off the ground the more the extra cultivation benefits the sal. It must, however, be borne in mind that the number of taungya cutters or jhumeahs is limited and the area cultivated each year not very extensive The Divisional Officer is faced with the fact that he cannot extend his sal sowings over further areas as long as the older sowings are being re-cultivated so that resowing cotton tends to arrest

progress in fresh areas. On the other hand if the cultivation is abandoned too soon grass comes in and tends to overwhelm and keep back the sal. Wherever sal has killed the grass its growth is wonderfully rapid. On well-drained land, however, two years' cultivation is probably sufficient.

As regards lower ground liable to inundation there is no doubt that this could, if necessary, be readily drained and would probably grow sal as well as the higher ground This would, however, add very considerably to the cost of the plantations and it would be better to plant soft wooded species such as Simul and Bischoffia on such areas. The last-named appears to stand inundation very well. Simul will also grow well but does not reach the same height as on higher ground. The forests are favourably situated being fairly near tea-gardens where there is a good demand for fuel and box planking This makes it easy to dispose of the material felled to make room for sal, etc., and also renders the artificial cultivation of soft-wooded trees such as Simul, Toon, Bischoffia, Gmelina and Duabanga a profitable undertaking. As the soft wooded species mature in less than half the time taken by sal to attain the same dimensions their cultivation may well be a better paying investment, regard being had to the fact that capital doubles itself every seventeen years or even less at current rates of interest. Simul and Gamhar, for instance, will probably reach a marketable size in one-third of the time taken by sal and would probably pay better even if the royalty realized was only ⅛th of that obtained from the harder timber. An area cultivated with field crops often becomes a savannah after cultivation ceases and the problem in regard to these sal sowings is to find some species which will kill out the grass, without subsequently suppressing the slower growing sal. The species must also be robust and not require hoeing or intensive cultivation. Experiments have been started with *Erythrina* and *Tephrosia candida* might also be tried.

The writer is of opinion that the present experiments as regards sal have not yet reached finality and that other alternatives should be considered. For instance alternate lines of

sal and some other species planted at intervals of about 15 feet would appear practicable The alternate line might contain a mixture of, say, Simul and Gamhar neither of which require much tending after the first year. By the time the branches of the mixed tree crop had bridged the gap of fifteen feet and killed out the intermediate grass the sal would be tall enough to hold its own and should be out of danger of supersession by the quicker growing soft-wooded species. The lines of sal would be 30 feet apart and it would be a simple matter to keep these fairly clean and weeded for a year or two after cultivation had ceased. One line only would have to be tended as compared with five lines of the present spacing. *

The writer also had an opportunity of seeing plantations of species other than sal. These comprised *Duabanga*, *Gmelina*, *Bischoffia*, Simul and Toon planted 6′ × 6′. Toon has suffered badly from the borer in spite of which it does fairly well in a mixed crop in which it is not the predominating species. *Gmelina* suffers from the depredations of a defoliator as well as being subject to ravages by deer. Various mixtures of the above species have been tried. Simul has been planted by itself and appears to require less attention than any other species, natural reproduction being quite common.

All these species become established in the first year and when planted 6′ × 6′ kill out the grass in their vicinity by the 2nd or 3rd year at most. Experiments in the lopping of the lower branchlets have been started in order to force the leading shoots.

Of all the species tried there is no doubt that the slowest to grow and the most difficult to deal with is the sal and it really seems hardly worth the trouble and pains which have been taken to re-establish it as the principal species in the Dooars. It is damaged by pigs which eat the roots of the younger seedlings but more so by grass, the rhizomes of which appear to have a most deleterious effect on the plants. It is not difficult to prove this. In a nursery at Mendabari sal grown in a plot kept free of grass has reached the pole stage in five years. Sal grown in areas

* [ED.—The proposed spacing would undoubtedly be too wide.]

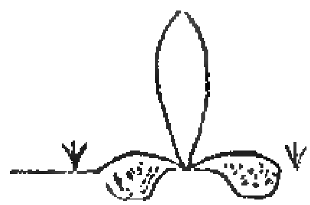
previously under forest gives infinitely better results than that in areas previously under grass and the writer was much struck by the fact that the thickly sown sal appeared to hold its own against the enveloping grass better than where it had been dibbled in more sparsely. If the writer may be permitted to express an opinion he is inclined to advocate the planting of sal together with other species such as *Gmelina*, Toon and Simul. The sal might be sown fairly thickly in a few wide parallel strips at intervals of not less than 30 feet and the intermediate land sown or planted with good soft-wooded species 6′ x 6′. As at present field cultivation should be carried on till the second year. The soft-wooded species would mature and be removed in fifty or sixty years after which the forest would be one of pure sal. It would not be difficult to keep the few lines of sal (30′ apart) as clean as the nursery bed at Mendabari, should there be sufficient sal seed available. In this connection it is curious to note that whereas 1919 was a bad seed year in the Dooars it was a record year for seed in Chota Nagpur. If in any year the sal seed is so scarce as to prevent a really thick sowing of sal, the grass near the strips of sal could be kept back by sowing *Tephrosia* (a local leguminous shrub used by planters for green manuring tea bushes). This might be sown with the field crops in the second year in two lines a couple of feet away from and on either side of a centre line of sal so as not to choke it At the end of the second year it should be pruned down to ground level and the prunings dug into trenches made close to and on either side of the 18-month-old sal seedlings. This treatment would obliterate the grass and at the same time stimulate the growth of the sal saplings which in the third and subsequent years should hold their own with the *Tephrosia* which in its turn will keep the grass off the strip of sal lying between the two strips. If the *Tephrosia* proves troublesome it can always be cut back. It grows slowly and takes some years to attain six feet in height and never exceeds ten feet.

The following diagrams show what should take place in the course of 30 months after the first sowing of sal takes place :—

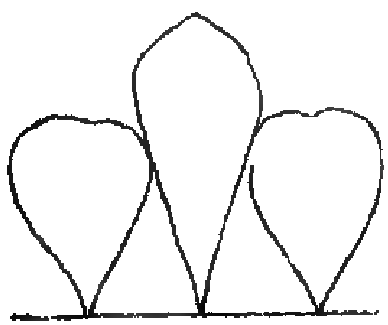
November 1920. Sal 6 months old.

November 1921. Sal 18 months, *Tephrosia* 6 months.

November 1921. After trenching *Tephrosia* prunings.



November 1922. Sal 30 months old.



This procedure appears expensive but it is a common experience that money spent in the first two years of tending so as to give the young plant a really good start saves labour in weeding, grass-cutting, etc., in subsequent years.*

Under certain tropical conditions within the writer's knowledge it has been even found economically desirable to raise trees in pans and flower-pots with rich soil so as to increase their initial vigour before planting out. This is, however, unnecessary in the

* [Ed.—This treatment would be analagous to the mixture of Teak and *Leucaena glauca*, also a leguminous plant, in Java in Teak *taungya* plantations. It is very successful in keeping down heavy grass.]

Dooars. Fencing is essential and an interesting point in this connection is that pigs are said not to pass through a fence through which they cannot see and the "ekra" fence commonly used by the Garos though weak and lasting only a short time appears tolerably effective. Stiles are preferable to gates Fences do not readily keep out deer, bison or elephants. So far elephants have not done much damage to the plants though they cause havoc to the villagers' crops.

Fire is a danger to the newly made plantations in few of which has the grass been anywhere nearly obliterated. Fire kills out most species except sal and sal is thrown back some three years or so.

If grass-cutting is delayed till the cold weather the leaves of the young sal get scorched and blackened. It has been found that this can be prevented by making the last cleanings not later than September.

F. T.

TEA BOX INDUSTRY IN UPPER ASSAM.

Manufacture of tea boxes commenced in Upper Assam in the early sixties; but no organized and systematic arrangements were made with saw-mill agencies till 1869-70, when they were authorized to fell and remove timber without restriction in size, quantity, quality or control, on condition that a rate subsequently fixed by the Forest Department should be paid (*vide* Mr. T. J. Campbell's History of the Forest Department in Assam). Since then various modifications have been made in the arrangements.

In its infancy, the industry had to contend against a fierce competition from abroad, as shooks from Norway and Japan used to flood the province. To give active encouragement to this important local industry which so closely concerns Assam, various concessions were allowed from time to time to saw-mills. These concessions and other circumstances and the cessation of imports during the war have led to its present flourishing condition. Local saw-mills are now turning out several millions of tea boxes and planters are drawing almost their whole supply from them.

The following brief account of the Badutti saw-mill with which the writer is closely intimate, will explain how tea boxes are generally manufactured by saw-mills in Upper Assam. Under the prescribed agreement which contains 25 conditions, the mill obtains the whole of its timber supply for tea boxes from a block comprising about 300 square miles of unclassed State forests. The block is annually inundated during the rains and consists of alluvial land along a net work of streams navigable during the monsoon, and as such is the habitat of damp evergreen forests where trees suitable for box-making abound.

The following, species, which have been arranged in order of merit, are permitted to be cut by the mill for the purpose of manufacturing tea boxes.

1. Simul *(Bombax malabaricum).*
2. Roghu *(Anthocephalus Cadamba).*
3. Bonjalukia (*Cryptocaria floribunda*).
4. Borun *(Cratæva lophosperma* and *Cratæva religiosa).*
5. Paniamora *(Garuga pinnata).*
6. Satiana (*Alstonia scholaris*).
7. Bon Hingalu (*Litsaca Spp.*).
8. Honalu (*Litsæa polyantha*).
9. Bon Homalu (*Beilschmiedia Roxburghiana*).
10. Bhelu (*Tetrameles nudiflora.*)
11. Borpat (*Ailanthus grandis*).
12. Kakoi (*Wendlandia puberula*).
13. Sum (*Machilus bombycina*)
14. Am (*Mangifera indica*).
15. Bandordima (*Dysoxylum Spp*).
16. Pahari (*Sterculia alata*).
17. Dhekela (*Trewia nudiflora*).
18. Tepok (*Garcinia Xanthochymus*).
19. Mohita (*Celtis tetrandra*).
20. Ramobih (*Æsculus punduana*).
21. Boramthuri (*Talauma Hodgsoni*).
22. Pichola (*Kydia calycina*).
23. Borthekra (*Garcinia pedunculata*).
24. Bual (*Ehretia acuminata*).

These species possess almost all the qualities required for making tea boxes and their logs float even when green. Simul is the best and most abundant and consequently most largely used. It will not be out of place to mention here that to ensure a constant supply of this valuable timber artificial regeneration has been commenced in places and felling of Simul has been prohibited over 1' girth in annual patta land in certain areas within a distance of 1½ miles of a floating stream. Exploitable size is a girth limit of 4½ in case of all the species except Simul which cannot be felled below 6' in girth.

Trees are selected by the saw-mill employés, marked with the registered hammer of the mill and felled early in the year. The bole is cut into logs from 10'—15' in length with the axe. They are again marked with the same hammer and dragged by the shortest *route* to the banks of the nearest navigable streams where they remain till floating is possible which is usually during August and September when no danger from flood is anticipated. To make rafts they are longitudinally attached to one another with Jatibet (*Calamus tenuis*) and poles of inferior species. Rafts are then floated down to the mill which is situated on the right bank of the Subansiri river. Logs remain in the water at the Mill-ghat till they are dragged to the factory-yard. This immersion of logs seasons them well and prevents discoloration of their soft white wood.

The machinery of the mill consists of one engine of 15 N.H P. which is capable of simultaneously working one planing machine and six saw benches, namely, one breaking down, one sizing, one cross-cutting, one corner-piece-cutting and two shook-cutting benches. When fully worked, the factory is capable of daily turning out 400 boxes out of about 50 logs each having a cubic content of about 17 cubic feet of timber.

The dimensions of the boxes are within the following limit :—

Large box not larger than		24" × 24 × 20".
Medium "	"	22" × 19 × 18".
Small "	"	19 × 18" × 15".

The rates of royalty to be paid to the Forest Department for tea boxes of above measurements are :—

For each large box despatched from the mill one anna.

Do.	medium	„	„	nine pies.
Do	small	„	„	six pies.

A box consists of about 20 shooks half an inch thick and four triangular corner-pieces with sides 2" broad. After the shooks have been sawn up they are stacked on end (3 or 4 being in one stack, leaning one against another) in the mill yard and exposed to the rain and sun for 5 or 6 days,—this seems to be quite enough for their successful seasoning. They are then taken to the godowns and kept in bundles, till they are despatched either by boat or steamer or carts to tea-gardens.

Turning to the financial aspects of the industry, it may safely be estimated that the profit is seldom less than cent per cent. The present sale price is Rs. 2-8-0 per big, Rs 2 per medium and Re. 1-8-0 per small box. In Badutti saw-mill the current year's estimate of outturn is 120,000 boxes of all three kinds. There are eight other mills in Upper Assam, some of which are bigger and some smaller than this mill. With the gradual extension of tea cultivation, a much brighter future for this rising industry is anticipated

SASI MOHAN DEB,
Forest Ranger.

LENGTH OF TIME TAKEN BY SAL SEEDLINGS TO ESTABLISH THEMSELVES.

In 1913 a plot measuring 23' × 26' was laid out in rather open sal forest in which there was a dense miscellaneous scrub undergrowth about 10 feet high. In this plot and in the surrounding area there were several sal seedlings all apparently of the same age and from the seed year of 1910. The scrub was completely cleared from the plot in November 1913, and the plot was fenced with barbed wire.

In November 1914 there was very little difference in the seedlings inside and outside the plot. The seedlings on half the plot were cut back to ground level, and the plot cleared.

In November 1915 it was noted that the seedlings had grown very little but that they looked healthier and straighter, those that were cut back being slightly larger on the average. The plot was cleared, the whole surface dug over and the soil loosened.

In the year 1915 the whole area in which the plot lies was cleared, that is all inferior miscellaneous growth up to two feet in girth was cut out.

The seedlings were not counted when the plot was laid out but it was recorded that in November 1915 there were 68 seedlings in the plot and they were from one to two feet in height.

After this no observations are recorded until in November 1918, the seedlings then were from two to four feet in height and looked much better than those in the grass and shrubs outside the plot. The plot was again cleared.

In November 1919 the plot was full of well established young plants. The best were about six feet in height and about five inches in girth at the base, there were also many about four to five feet in height.

At the time of writing (February) the plot contains about twenty-five fully established lusty young plants all growing well and some smaller ones that are not as yet fully established. The plants on the western half which were cut back to the ground in 1914 are certainly now far better developed, thicker, taller and straighter than those in the other half. Outside the plot there are still many young plants but they are nowhere so numerous and not nearly so well developed as those inside the plot. The difference can only be attributed to the regular cleanings and possibly the fencing. The whole outside area was cleaned in 1915, but the annual cleaning seems to have made all the difference, helped by the cutting back on half the area of the plot.

It is interesting to note that in this case naturally sown seedlings have taken ten years to develop into a full crop of fully established young plants. In this Division there are fifteen

10′ × 10′ sal seedling plots laid out in 1913 and stocked with seedlings of the 1913 seed year. The plots are in localities in which the density varies from quite open to very dense, but in no case yet are any seedlings approaching the stage of being fully established.

W. A. BAILEY,
I. F. S.

A NOTE ON THE MATCH INDUSTRY AT KOTA IN THE BILASPUR DISTRICT, C. P.

The Factory which is situated at Kota (Kargi Road Station, B.-N. Ry.) is owned by Mr. Amrit Lal, a Gujrati Kunbi, and is known as the Amrit Match Factory. It was started in the year 1902 and the daily average output for some years was about 500 gross match boxes. Of late years the industry has, owing to financial difficulties, fallen off considerably, and during the period of the late war, the work was practically dislocated on account of high prices and the difficulty in obtaining chemicals and other requirements from Europe. At present the daily outturn of match boxes varies from 175 to 250 gross, and the average may be taken as 200 gross.

Soft wooded species only are utilized in the manufacture of veneers for both match splints and boxes, and the chief among these is the Semal (*Bombax malabaricum*) Among other species also used are Salai (*Boswellia serrata*), Kekad (*Odina Wodier*), and Kulla (*Sterculia urens*) Salai is used for the bottoms of the inner drawers (match boxes) and also for packing cases. Kekad and Kullu are used for packing cases only.

The wood used for the match splint and box veneers must be green and should reach the Factory within a fortnight of felling, otherwise it becomes necessary to boil the wood for 24 hours before utilizing it. In the case of Salai, however, due to the brittle nature of the wood fibres, it is necessary to boil all logs before utilizing them. The boiling is to render the wood soft and easily workable by the veneer machines, and only such logs as have not developed cracks are suitable for veneering even after being boiled.

As already mentioned above, only Semal and Salai are used for the manufacture of veneers, the former for both splint and box veneers, and the latter for veneers only for the bottoms of the inner drawers. The restricted use of the Salai for veneers is due to its brittle nature, it not being possible to bend the veneers without breaking them.

The logs Salai and Semal) when brought to the Factory are sawn into blocks 16 inches in length, so as to fit into the wood peeling machines, and, after barking, should have a diameter of from 5" to 27". It will thus be seen that logs under 16" girth are not suitable for the making of veneers.

The wood peeling machines.

These are of two types, one being designed for making veneers for match splints, and the other for the production of match box veneers. The former is fitted with a fixed knife and pressure bar, by the use of which latter the veneers are obtained absolutely smooth and of an uniform thickness.

In addition to the above fittings the peeling machine for the making of match box veneers is fitted with lance holders which not only trim the veneer on both sides and divide it into bands suitable for outer drawers, side parts and bottoms for drawers, but make incisions simultaneously in these veneer bands for bending the edges of the boxes. The lance holders are arranged in such a way that the incisions are always of uniform depth without any special adjustment of the holders being required, whatever may be the diameter of the block.

The match splint veneers are about $\frac{1}{12}$th of an inch thick and the match box veneers about $\frac{1}{30}$th of an inch thick.

The thickness of the match box veneers is regulated according to the elasticity of the wood employed, the more elastic the wood the thinner the veneer.

Splint chopping machine.

This machine serves to cut into splints the veneers that have already been prepared by the peeling machine. The veneer lengths in packages of from 60 to 70 layers and ranging from 5" to 6" in depth, are placed on the rollers at the rear of the machine and are fed

to the chopping knife by means of fluted rollers which seize and clamp the layers on each side. A ratchet wheel regulates the feeding of the veneers and two chopping knives arranged end on, one behind the other and covering the width of the veneers, work vertically downwards, while eight other knives fitting in between the chopping knives and working simultaneously with and at right angles to their cutting edges, divide the splints into seven pieces. As already stated the veneers are about 14″ wide and are arranged in packages of from 60 to 70 layers, so that with each downward stroke of the knives (60 to 70) × 7 splints, each about 2″ long are produced. They are collected in heaps on the floor or in baskets placed on the ground to receive them.

Splint drying chamber

The splints when ready are conveyed to the splint drying chamber, for drying. The chamber consists of compartments between which are arranged ribbed heat radiating pipes. The process of drying in the chamber is, however, dispensed with in dry weather, when the splints are dried in the sun.

Splint polishing apparatus

After being dried the splints are removed to the splint polishing apparatus in which the polishing of the splints is carried out by friction against each other and their quality greatly improved. This apparatus consists of a drum mounted on iron stands. The framework of the drum is of iron and, except for the facings, is enclosed in a wooden casing. It is driven by fast and loose pulleys.

The splints having been filled into the drum, it is closed and set in rotation until the splints are sufficiently polished The drum is now emptied and filled again with fresh splints.

Splint cleaning machine

After being polished the splints are taken to the splint cleaning or sifting machine which is erected on an iron stand and is provided with a grille and case hopper, the latter for receiving the splints to be cleaned. The grille and the case hopper form separate parts and each has a separate motion, the former working backward and forward and the latter from side to side. The grille consists of

longitudinal and cross bars, the space between which is determined by the length of the splints. When the machine is set in motion the splints fall from the case hopper on to the grille in a horizontal position and those that are too short or broken, as also dust, fall through the space between the bars, while the whole splints are retained, and passing the grille over its entire length drop at its fore-end into a case placed on the ground to receive them.

Levelling machine.

After being cleaned the splints are taken to the levelling machine which is fitted on a strong angle-iron frame. The machine is provided with a wooden box frame divided into small rectangular compartments, the size of match boxes, and arranged one behind the other. This box frame, which is employed for the levelling of the splints, serves as bottom for an upper case, also of wood, and into which the cleaned splints are thrown promiscuously. By a powerful oscillatory motion, the splints settle down into the small receptacles in the box frame. The filled box frame is now removed from the machine, covered by a board, and both are turned over. On lifting the frame, the splints will be found lying in parallel rows on the covering board. These are now packed compactly by hand in a wooden frame called the bundling frame and are taken to the frame filling machine and placed above the filling frame on two shaking arms which drop upon the filling frame. The filling frames are constructed of wooden cross beams and laths with screw fastened drawn wrought iron rods and fastener, and at least 300 frames have to be provided for each machine for the purpose of maintaining uninterrupted working. The mechanism of the machine is much too complicated for a detailed description, but suffice it to say that with the setting in motion of the shaking arms on which the bundling frame has been placed, the splints pass below perpendicularly into the filling frame between the laths. Here the splints are automatically, compactly packed and held tight in rows, and in such a manner that their ends both at the lower and upper surface of the frame are on an uniform level. This is essential for the

Bundling frame and frame filling machine

uniform dipping of the splint ends in the paraffining and dipping machines later on.

Drying racks.

After the filling frames have been filled with splints they are kept on drying racks provided with heat radiating pipes. This reheating of the splints is necessary for the ready absorption of the paraffin by the splint ends. It prevents the paraffin from congealing too quickly so that it is thoroughly absorbed and does not merely clog the surface of the splint.

Paraffining machine

After the splints have been sufficiently heated the splint filled frames are taken to the paraffining machine where they are pushed on to a support of angle irons arranged above the paraffining tank, and automatically dipped for a moment into the paraffin to a depth of about $\frac{1}{8}$th of an inch. The quantity of paraffin in the pan can be regulated for the desired level, so that it is easy to fix with accuracy the depth of submersion of the splints in the paraffin. The object of the paraffining is to assist the splints to catch at once the flame produced on ignition by the match head composition. It is, therefore, necessary that the paraffin should not extend too far down the splint, as otherwise the whole splint would burst into flame with the ignition of the match head composition.

Dipping machine.

After paraffining, the splint filled frames are taken to the dipping machine where the setting of the heads of the match splints is performed. The frames containing the splints to be dipped are placed on the revolving table one behind the other with paraffined ends downwards, and as they pass in succession under the pressure plate, the paraffined ends of the splints dip automatically into the match-head composition below. This done the splint filled frames are again placed, with match-heads downwards, in the drying racks. Here they remain for 3 to 6 hours till the match-heads are dried. The match sticks are now ready for filling in boxes.

The pealing of the box veneer for outer drawers, side parts and bottoms of drawers has already been described above.

Box veneer chopping machine.

The veneers are cut up by the box veneer chopping machine into rectangular pieces (skillets). The veneer lengths are packed in the same manner as for the splint chopping machine, vertical rollers adjustable to the required size and width of the veneer packets, pushing the latter automatically forward to the knife.

Outer case and inner drawer pasting machines.

These skillets are taken to the outer case and inner drawer pasting machines, where they are finished into outer cases and inner drawers and covered with wrapper labels.

Labelling machine.

The outer cases are now labelled. This is done by the box labelling machine, but the machine being out of order the labelling is done by hand at present. The outer cases and inner drawers of boxes being now ready, the prepared match sticks are filled by hand into the latter and the boxes closed.

The boxes are now taken to the machine for painting their sides with friction composition. This machine is provided with two sets of horizontal brushes which paint the boxes one at a time, simultaneously on both sides. After passing the brushes and being painted with the friction composition, the boxes move forward one behind the other along a drying channel heated by steam, and by the time they reach the end of the drying channel, the painted sides are dried.

W. J. ANTHONY,
P. F. S.

EXTRACTS

F. P. S.

EXTRACTS.

BOXES FROM PAPER PULP.

Owing to the growing scarcity and fast-increasing price of timbers suitable for the manufacture of butter boxes, the question of utilization of an appropriate substitute is being widely discussed amongst exporters. Old straw, cornstalks, and similar waste products have suggested themselves to many persons as possible materials for conversion into strawboard, and apparently the view is largely held that the only difficulty to be overcome

is that of chemical treatment. At the request of the Primary Producers' Union of New South Wales, and of the Department of Agriculture, New South Wales, the Chemical Committee of the Institute of Science and Industry was recently asked to investigate the proposal; but it would appear from their report that many economic problems are involved, and that established trade practice must be considered in relation to the general inquiry. From a preliminary survey of the position, it appears that the cheapest raw material available in quantity in South-Eastern Australia for making paper pulp is undoubtedly straw (wheaten or oaten). This usually costs from 30*s.* to 40*s.* per ton—little more than the cost of collection and cartage.

The Committee reported that, in attempting to utilize old straw, cornstalks, etc., the expensive treatment and the low yield of cellulose pulp have to be considered. It is doubtful if it would pay to collect for this purpose any material now discarded as rubbish. Assuming then that straw boiled with lime and beaten to a pulp is used, it might either be pressed into boards or cast directly into a one-piece box Although a water or air-proof package is not required for the carriage of butter, yet this straw pulp box must be specially treated to make it adherent and strong enough, particularly when exposed to water. Straw-board, when wet, has also an objectionable smell Probably these defects could be overcome by the addition of some binding and hardening material, such as paraffin wax, resin, soap, or waterglass etc., which would reduce the porosity of the board. Obviously, odorous water-proofing varnishes, such as magramite and linseed oil, must be avoided.

Another consideration is the cost of the material. The pre-war cost of strawboard was less than £10 per ton, and it now sells for about £28. The elaborate and expensive machinery required for calendering the board is responsible for a large proportion of this cost, and would not be required for making pulp for butter-box construction. On the other hand, special moulds and presses would be required. A further reduction in cost is probably possible by incorporating sawdust (after special treatment)

or other filling material, with the pulp. Such a mixture could be poured into suitable moulds like concrete. There are objections to a square-cornered box being cast in one piece, but, if the trade could be induced to pack butter in boxes of the present capacity, but made with rounded corners, a method of construction which might possibly be feasible suggests itself. The lid of the box could be made in the form of a round-cornered tray about 3 inches deep. It should fit nicely like the lid of an ordinary cardboard box, and could be secured in place by means of a glued strip of paper.

On account of the shape, they could be stronger than square-cornered boxes, and could, therefore, be made of thinner walls, and with a considerable saving of material. They would also pack economically without any reorganization of the present system of handling. While this appears to be the most promising method of utilizing straw pulp, it is obvious that much investigation is required before it could be adopted—investigation in the laboratory, with the assistance of some paper-mill machinery to determine the most suitable pulp—and experiments on the mechanical side to construct effective moulds, dies, and presses with which to form and consolidate the boxes. With reference to the proposal recently before the Institute of Science and Industry for the establishment of a small and comparatively inexpensive paper-mill for experimental purposes, it may be mentioned that one of the above is just the problems for which its help would be invaluable.—[*Science and Industry*, Vol. I, No. 7.]

TIMBERS OF TRINIDAD AT THE TIMBER EXHIBITION.

It is understood that the exhibit of the timbers of Trinidad to be displayed at the Exhibition organized by the Department of Overseas Trade and Development, to be held in London in July, will be taken charge of by the Cambridge School of Forestry, under the personal superintendence of Mr. Herbert Stone.

VOLUME XLVI NUMBER 7

INDIAN FORESTER

JULY, 1920

A PLEA FOR REORGANIZATION AND DEVELOPMENT IN THE CENTRAL PROVINCES.

We have heard much of late regarding the reorganization of staff in various provinces to cope with the boom in forest research and the development of industries dependent upon forest products. Rumours and more than rumours are rife regarding the mushroom growth of special appointments—Technologists, Sylviculturists, Utilization and Research Officers—with corresponding Conservators to control their various activities. Schemes have been formulated for the introduction of more up-to-date methods of forest exploitation, mostly on the lines of the expansion suggested for the Research Institute at Dehra; and these schemes have already materialized in more than one province, where those in authority realize what unlimited fields for enterprise and enquiry have been opened up by the adoption of a policy of development.

Having been for some years out of touch with the C. P. I must confess my ignorance of recent developments there; the only excuse for my temerity in putting forward this effusion is that its faults may goad some already overworked D. F. O. to

break for once his habitual literary reticence, tell us 'what's doing' and so justify or condemn my presentation of the subject.

In order to effect my object of drawing criticism from those who know, I propose to give my own views on the general nature of forest conditions in the C. P. and the lines of possible development; such brief description as I may be able to give may do something to enlighten many whose only idea of the C. P. is limited to the impression that it is a 'damned hot place where you spend your service collecting grazing-revenue and shikaring in scrub jungle'; or, as a brother officer the other day pathetically put it: 'The only thing I've heard of in the C. P. is the afforestation of Seminary hill.' Such a remark alone is sufficient justification for a short description of our work, our aims, and our needs.

To start with, the conditions in our C. P. forests are somewhat peculiar, in that the potential value of the so-called 'minor' products probably exceeds the actual value of the major produce; and that these minor products are very far from being limited to grazing dues it is one of the objects of this note to show. Another striking characteristic of the C. P. is the large size of the divisions and ranges. There are at least six divisions of over 1,000 square miles, the largest having an area of close on 1,700. For ranges 250 square miles is common, while one range in Nimar is 375 square miles. Not only are we extremely short of staff to deal with these large areas but the lack of good communications by road, in spite of a not inconsiderable pre-war boost in that direction, is still very apparent in most divisions. As regards the forests themselves, with the exception of small isolated 'pockets' of really good forêst such as are found at Alapalli, Bori and in parts of the Melghat and other divisions, the timber stand is poor besides being of relatively small dimensions, and extensive areas of grass and scrub-clad reserves exist. In spite, however, of the small dimensions attained, such forests possess their own peculiar sylvicultural and other problems whose solution is eminently desirable. There is no reason to suppose that the response to correct sylvicultural treatment would be proportionately less in these than in other forests. The timber finds a very

ready market either locally for house-building purposes and for railway sleepers or, in the case of larger dimensioned material, for export to the north or to Berar and Khandesh. With the notable exception of Alapalli, departmental working for timber is unknown, the general practice of exploitation being to lease the annual coupes to small contractors who work them out mainly by the agency of our forest villagers. The obvious defect of such a system is that we have practically no knowledge whatever of the value of our timbers, and many really valuable species such as *Adina, Anogeissus, Stephegyne*, the *Grewias, Stereospermum, Gmelina*, the *Gardenias, Holarrhena, Diospyros*, the *Albizzias* and many more remain unexploited in the coupe. The reasons are that they do not generally exist in sufficient quantities in any areas leased by one contractor to make it worth his while to exploit them, and no organization at present exists for the collection in commercial quantities and marketing at one centre of the supplies of such timbers as could be made available from a large number of different felling areas. Working plans exist for all workable areas but the systems on which the forests are worked are limited to those of coppice with standards and improvement fellings and in some cases, selection cum improvement fellings. In all cases the fixing of the rotation is entirely arbitrary, and for all practical purposes regeneration is left to chance; organized sylvicultural research is unknown, and practically no information is available regarding such matters as the best methods of propagation, the regeneration, the rate of growth or the quantities of timber annually available of the more important species. Accurate knowledge on all these subjects is essential to enable the maximum of profit to be derived from the efficient working of the forests. The so-called 'minor products' are numerous and very diverse in their nature, the following being perhaps the most important :—

Fuel, bamboos, grass and grazing, myrabolans and other tan-stuffs, lac, rusa grass oil, Boswellia Gum-oleo-resin, Cutch, mohwa flowers and fruit, gums, sambhar and chital horns, bees-wax and other items of less importance down to the right of collecting parrots in Damoh.

It is not proposed to discuss these in any detail in a note of this kind, but a few remarks may be made to indicate the almost unlimited opportunities that exist, and the extreme desirability of increasing our knowledge regarding these minor products, in order to develop the potential industries dependent upon them and so swell the derivable revenue.

Up to comparatively recent times, and with the exception of some of the better known products whose value was already well known, such minor products were grouped together and disposed of under annual leases for their collection. The lessees are in many cases local men of small standing who merely serve as collecting agents from the forest and other villages; they dispose of the products thus obtained to brokers or other collecting agents in the larger towns, who in their turn pass on their supplies to the larger exporting traders in the headquarters stations. Thence the products are packed and despatched to other brokers or selling agents in Bombay, Calcutta or elsewhere, who in their turn pass them on to the wholesale dealers or shippers. It is thus perfectly obvious that the share derivable by Government from such products is infinitesimal and can in no way be said to represent their true value. As regards the products themselves, the following brief notes will serve to indicate the scope and possibilities for development.

Fuel.—Though the importance of the regulation of the fuel supplies to the larger stations is already recognized, lack of staff has precluded the possibility of taking any practical steps to effect such regulation by departmental agency, and for the same reason the possibility of charcoal manufacture on a large scale has not come up for serious consideration.

Bamboos.—The question of the export of bamboos from the C. P. and the co-ordination of the royalties levied throughout the province is one well worthy of attention, as also is that of an organization of an agency for the collection of the solid male bamboo for which there is such a special demand for military purposes.

Fodder Grass.—Of grass operations perhaps the less said the better—they have been the bane of the D. F. O.'s existence during

the war—for though, in spite of many difficulties, they have been developed in a wonderful manner, yet the chief reason for their unpopularity lies in the fact that such work has in most cases had to be performed by D. F O.'s in addition to, and at the expense of, their legitimate duties. The essential necessity for such operations and their value both to the army and in famine years having been now definitely established, it may be suggested that such work should become a permanent institution in the province, but in that case a special organization and staff—quite apart from that of the division would obviously become necessary.

Grazing is perhaps hardly a 'minor product,' being more in the nature of a subject calling for special study. The grazing settlement is now an essential adjunct to every working plan and its method of compilation can hardly be improved upon. The fly in the ointment lies in the grazing rules themselves, for though on paper they may appear ideal, yet the detailed scale of differential rates, the practical applicaton of which rests in the hands of the patwaris, makes efficient check by the forest staff a very intricate and laborious business and one moreover well calculated to generate friction in working.

Tanning materials.—The importance of the C. P. forests as a valuable source of tanning materials has already been recognized. The most important of such products are—Myrabolans, bark of Koha (*Terminalia Arjuna*) and Babul (*Acacia arabica*) and the leaves of Dhaura (*Anogeissus latifolia*), while the possibility of cultivating Tarwad (*Cassia auriculata*) in many parts of the province remains a subject for investigation. Again what is required is an organization for conducting experiments and arranging for the collection and disposal of the products on a commercial scale.

Lac.—The possibilities latent in the departmental expansion of lac cultivation have already been realized, and have been made the subject of special enquiry which may be expected to have far reaching results. The subject forms a notable instance of a very common product whereof the extreme value and ease of propagation has long been recognized bu of which, until quite recently,

no practical steps whatever have been taken to effect an increase of outturn and revenue.

Rusa grass oil and Boswellia turpentine.—The possibilities of starting industries in the extraction of Rusa oil and in tapping Boswellia for its gum-oleo-resin, which is known to be a valuable source of turpentine, have already been dealt with by the Research Institute in Forest Records It now remains to examine the possibility of propagating the "Motia" variety of the grass in suitable localities, and to undertake operations on a large scale in the field with a view to demonstrating the possibilities of establishing such industries on a commercial basis.

Cutch has been exploited on a small scale by certain wandering aboriginal tribes for a number of years in the north of the province, but the revenue derived has been nominal. The Khair tree (*Acacia Catechu*) occurs in considerable quantities and is almost gregarious in parts of some divisions; it would certainly appear worth considering the possibilities of an up-to-date extraction plant on the lines of the Cutch factory recently erected in the Ramnagar Division, U. P.

Mohwa flowers.—The practicability of exploiting Mohwa flowers as a source of alcohol remains to be investigated. The extraction of alcohol is a simple matter, but, as the flowers constitute a valuable source of food supply to those living in the vicinity of the forests, the question as to what quantity over and above that required for local consumption may be available will necessitate detailed enquiry, and it may even be necessary to encourage the propagation and cultivation of the tree.

Gums, Horns Beeswax, etc—As to the value of these exceedingly little is known but that little indicates the advisability of collecting and keeping separately the various classes of gums, of grading horns according to species and size already recognized on the market, and of finding some means of preventing the adulteration of wax. Needless to say each of these items will require a special study of present methods of collection, disposal and markets before even an approximate estimate of their true value can be arrived at.

While the exploitation of the ornithological possibilities of the province is unlikely to yield any largely increased revenue, a study of the present system of parrot leases might not be devoid of interest to bird lovers with humanitarian tendencies!

Having attempted to give the briefest possible review of present conditions and some of the problems awaiting solution it remains to make a few practical suggestions for the amelioration of the admitted defects and for possible lines of reorganization. In doing so it must be admitted that this note lays itself open to every sort of criticism, but as the chief object of the writer is to provoke such criticism no apology seems called for.

In the Inspector-General's recent inspection note on the South Raipur Division allusion is made to the reallotment of divisions, the control of Zamindari forests and those of Feudatory States, the improvement of communications, the appointment of research and utilization officers and the amelioration of conditions for taking recess to Pachmarhi or Chikalda.

It may be of interest to examine these proposals in greater detail. As regards administration, allusion has already been made to the unwieldy size of many of the divisions and ranges so that partition of such divisions with a corresponding increase in the number of circles, on the lines of the reorganization which has recently taken place in the Punjab, U. P. and Burma would appear to be more than justifiable. There seems a clear case for the formation of at least five territorial circles constituted as follows:—

Northern Circle.—Headquarters Jubbulpore and six divisions, *viz.*, Saugor, Damoh, Jubbulpore, North Mandla, South Mandla and Seoni.

Nerbudda Circle.—Headquarters Pachmarhi and six divisions, *viz.*, Narsinghpur, East Hoshangabad, West Hoshangabad, Betul, North Nimar and South Nimar.

Berar Circle.—Headquarters Chikalda and five divisions, *viz.*, Melghat, Amraoti, Yeotmal, Akola and Buldana.

Southern Circle.—Headquarters Chhindwara and six divisions, *viz.*, Chhindwara, Nagpur-Wardha, Bhandara, North Chanda, Central Chanda and South Chanda.

Eastern Circle —Headquarters Raipur and six divisions, *viz.*, Bilaspur, North Raipur, South Raipur, North Balaghat, South Balaghat and the Feudatory States.

Only second in importance to the desirability of reducing the size of divisions comes the question of improvement of communications as on this depends the possibility of more intensive exploitation and utilization of our major produce. Many divisions are still very short of adequate means of communication by road to their timber supplies and what appears to be required is a very liberal policy for the extension of first class metalled roads, not limited to divisional boundaries only, but with a through connection between markets or suitably situated railway stations and the centres of supply. It is doubtful if there is need to employ a highly trained forest engineer on this work; given adequate staff and funds, the work could be easily and satisfactorily carried out by D. F. O.'s themselves, as has been done in the past.

As soon as we have divisions of a convenient and manageable area with proper through communications from the centres of supply to the railways or markets, it become permissible to consider the appointment of special officers to deal with timber exploitation and utilization, the collection and disposal of minor products, and the development of industries dependent thereon.

Taking the case of timber first; for reasons already given the system of leasing annual coupes to contractors does not lead to anything approaching complete exploitation of the available material. The C. P. forests with their regular distribution of forests villages constitute an almost ideal example of the self-contained forest estate, eminently adapted to carry out such departmental operations as depend for their success on the concentration of labour supplies at convenient centres. Alapalli in South Chanda is an excellent example. Here we have a large forest village, practically a labour camp, whose inhabitants are almost entirely dependent on forest works for their livelihood. It has a dispensary, a weekly market and a school in which the families of the villagers are educated to fit them for the duties of forest guards, etc. Thus educated the Gond is ideal for the

purely executive, as distinct from the detective, duties of a forest guard, and can moreover live on his pay.

The next step in extending departmental exploitation would presumably be to form timber depots at suitable spots on the railway which would be supplemented by a few large sale depots situated at convenient market centres. Such sale depots would be fitted with simple saw-mills in which timber could be converted to market requirements, seasoned, and accumulated in commercial quantities Though departmental working need not be an essential, some such system as the above would appear to be indicated in order to facilitate the collection in commercial quantities, and marketing at one centre, of those species which, though not occurring in sufficient quantity to warrant exploitation from any one felling area, yet possess an appreciable commercial value when made available in bulk. As the quantities of timber thus made available are not likely to be very great nor the dimensions large, no detailed scheme of utilization need be contemplated for the present, the idea being rather to cultivate an acquaintance with, and cater for, the surrounding timber markets and firms requiring timber for special purposes, thus in fact supplementing supplies from other provinces.

As regards the personnel necessary to direct such a scheme as is outlined above, this could conveniently consist of an officer in charge of the classification and marketing of the timber in the large sale depots who might be designated a Timber Supplies Officer (T. S. O.) assisted by a staff of district exploitation officers whose duty would consist in arranging for the felling and extraction of the timber to the various district depots. The term T. S. O. is suggested, in preference to that of Utilization Officer, as being more nearly descriptive of the duties he will perform. One of the first duties of such an officer will obviously be to collect information and make an inventory of the possible supplies of the various timbers available from different localities, concerning which at present absolutely nothing is known.

Intensive exploitation will doubtless demand intensive and controlled regeneration. On this latter point we have been content

in the past to trust to nature to restock our felling areas, and, as already mentioned, nothing whatever is known regarding the proper rotation or the best methods of regeneration that should be adopted for the various types of forest. A very fruitful field for sylvicultural research therefore lies open and awaits the appointment of a provincial sylviculturist.

Coming now to the question of staff necessary to develop the 'minor products,' it has already been seen that the field of operations of the research officer in charge is likely to be a very wide one, necessitating not only a considerable amount of scientific knowledge but also an intimate acquaintance with the markets for the various products and with the commercial world generally. His duties will consist essentially in devising methods based on experiment for propagating or increasing the outturn of the various products, thereafter controlling and disposing of supplies, or developing industries dependent on them

A suitable designation for so admirable a Crichton is not altogether easy to find. The term 'Minor forest products expert' does not roll freely from the tongue, is derogatory and is certainly a misnomer in the C P. where there is every prospect that such 'minor' products will soon attain their majority. 'Economist,' apart from being a meaningless term, is suggestive of the financial policy so often imposed upon the members of our department. We are then faced with such titles as 'Forest Industrial Research Officer' or 'Forest Industrial Development Officer.' Of these the first does not do justice to his practical and commercial activities. The second describes his functions more precisely, and is moreover worthy of consideration on psychological grounds: for there can be little doubt that the possession of the telegraphic address of 'FIDO, C. P.' would of itself tend to inculcate or encourage in the incumbent of the post those qualities of reliability and the capacity for faithful ungrudging service with which the name is universally associated.

We now come to the last point suggested in the Inspector-General's note, *viz*, the improvement of the existing rules regulating the taking of recess by D. F. O.'s in Pachmarhi or Chikalda,

Under existing conditions there is little or no opportunity in the C. P. for 'getting together' for the general discussion of 'shop,' and the so-called concession to visit Pachmarhi or Chikalda for a period of six weeks during the hot weather is practically a dead letter; for the reason that there is little incentive to move, with travelling expenses of self and staff to defray and the certain prospect of finding no accommodation available. The extension of the period of recess to two months commencing from May 1st and the certainty of finding accommodation in 'the commodious rest-house' suggested by the Inspector-General would, however, ensure a well attended annual conference. The real value of such meetings is now fully recognized and from possibly informal beginnings a conference of this sort might well develop a more definitely official atmosphere and status. There can be little doubt that the benefits derived from such a concession would be sufficient to outweigh any arguments that might be advanced against it.

In conclusion it remains to express the hope that this attempt to indicate the forest needs and deficiencies of the C. P. may have the effect of inducing some more able pen to trace the lines for a sound constructive policy of forest development. It is above all desirable that the increase in cadre necessitated by such a policy should be definitely sanctioned in order that, when the general scramble occurs for the allotment to provinces of the recruits now under training at home, the C. P. may not find itself, metaphorically speaking, in the 'potage.'

HARK FORRARD.

NOTE ON THE ECONOMICS OF NOMADIC GRAZING AS PRACTISED IN KANGRA DISTRICT.

[We publish this note in amplification of Mr Grieve's article on the Forest Estate which appeared last month.—HON. ED.]

Grazing conditions in Kangra District are peculiar.

The tract consists of the low ridges and spurs descending from the main ranges of the Himalayas which they connect with the plains of the Punjab Their inhabitants, who are mainly cultivators, keep cattle for ploughing and manuring their fields. The whole country is, however, overrun with enormous herds of sheep and goats which are brought down from the neighbouring States of Chamba, Lahaul, and Bashahr to graze throughout the winter months owing to the scarcity of fodder in the snow-bound tracts which characterize these localities in winter The available grazing grounds of the Kangra District are divided into grazing runs, each being grazed over by the same gaddi year by year, on payment of a fee of 1 anna per goat and 9 pies per sheep per annum.

2. The latest available figures show that the average number of sheep and goats grazed annually during the past five years was 294,785 and on an estimated area (excluding unproductive land) of 595,977 acres, that is, an incidence of about two animals per acre. Now these animals graze only during the period of minimum production of fodder stuffs: and it is safe to say that such a heavy incidence must spell more or less starvation to the herds. On the other hand, over a large proportion of this area, probably not less than a quarter, and possibly as much as one-half, a valuable hay crop either grows naturally or could be easily grown artificially, by the sowing of hay seed and the closure to local grazing during the rains. In other words, we have half-starved herds of a quarter of a million animals devastating some 600,000 acres of land while a potential but usually wasted hay crop over perhaps 150,000 acres in the same district is waiting for a little organization to develop it! These are startling facts, and reveal an

economic condition of almost inconceivable wastefulness. Moreover, the herds which now devastate the district do not even belong to it, the Kangra District is suffering to benefit outsiders. Contrast these conditions with those under a more rational use of the land available by means of which it should be possible to reduce the present enormous area of the grazing run to a few hundred acres of exercise ground, each having its hay stock or main fodder supply conveniently situated in it.

THE GRAZING GROUNDS.

3. The areas grazed over consist mainly of scrub jungle with or without bamboos at the lower elevations, this being gradually replaced by forests of Chir Pine at higher elevations and sorely depleted grasslands. In neither is sufficient natural tree regeneration possible, as under the intensive grazing practised but few seedlings have a chance of establishing themselves. The scrub has in many cases already completely disappeared, leaving a series of sun-dried bare ridges, from which all soil is in process of rapid erosion, and which to all appearances are devoid of any sort of fodder. The Chir forests are usually very open, and the trees in them malformed, in short, they are undergoing similar deterioration due to the same cause. It is therefore clear that a continuance of existing conditions is in process of achieving not only the destruction of the forests, but also the diminution of the means of sustenance of the herds themselves. It is obvious that the right of grazing as now practised violates the fundamental condition underlying the exercise of any right, namely, that the factors necessary to its *permanent* satisfaction must be assured.

THE VALUE OF THE CHIR FOREST.

Mr. A. J. Gibson has kindly supplied the following note :—

"As regards resin, however, I can give you necessary details.

"Supposing the rotation is 120 years worked on a regular method, the area would be tapped for 60 years yielding 1½ maunds resin per acre per annum or 90 maunds in all having a net value of Rs. 8 per maund or Rs. 720 in all. With increasing timber values,

the timber return of Rs 8 or Rs. 9 is low, and of course I am not including any interest return. *I think you would be justified in taking Rs. 16 per acre per annum net as fairly safe for timber plus resin*, as in a fairly stocked crop the yield of resin will be over 3 maunds per acre per annum, while I am now only taking a fair average."

The total area which it is now proposed to remove from the care of the Forest Department amounts to 314,260 acres. Assuming that only one-tenth of this is fit for forest production, grazing, which produces less than Rs. 20,000 per annum, will eventually cost the district over 5 lakhs per annum from this source alone by preventing the proper conservation of these areas. It is therefore clear that the Forest Department can afford to offer villagers much better terms than it has hitherto done, in order to retain these valuable forest properties.

4. The conclusions arising from these conditions may be generally summarized thus: –

I.—That the production of a greater proportion of forest on account of its economic value to the district as well as on account of its soil retaining and fertilizing qualities is necessary to the welfare of the district.

II.—That the increased production of fodder crops to provide for the indigenous and nomadic herds which have their grazing grounds in the district is equally necessary.

III.—That the system of grazing as now practised is economically unsound, in that it subjects the district to the maximum incidence of grazing during the period of minimum fodder production.

IV.—That there is sufficient area of ground, if economically and intelligently used to provide for both.

V.—That it is impossible to use the same areas of land to produce both forest and grazing simultaneously without restrictions.

VI.—That the fundamental principle, that in cases in which a large artificial demand for any natural product has arisen, a corresponding *artificial* production of that

product is necessary, if its permanent supply is to be insured, must be recognized. This principle holds in fodder as in forest production.

5. The problem before us is, therefore, the permanent increase of both forests and fodder.

Its solution depends upon the recognition of two classes of closure, namely :—

(*i*) Fodder Reserves, *i.e.*, closures for increased fodder production only, and

(*ii*) Forest closures, *i.e.*, closures to insure that as far as possible all forests of value may be brought under systematic management.

(*i*) *Fodder Closures.*

6. The most important point to notice is (*vide* paragraph 2), that almost the entire natural and potential output of pasture grass of the country is wasted, because the herds are not there to eat it as it grows, and only reach it when it has seeded and become overmature, and consequently possesses a greatly decreased fodder value. *Since therefore the crop cannot be used as pasturage, it must be used as hay.*

Action on the following lines is suggested :—

An area would be selected in each sheep run for the hay crop of the year, and *after* the herds had left for the hills would be closed to all local grazing, and where necessary sown off with a crop of "Dholu" or spear grass. This would be reaped not later than October, that is before the herds return to their runs. The hay would be made and transported to the desired centres by light permanent wire-ropeways. Telegraph wire would be sufficiently strong and the loads would run by gravity, and then stacked to supplement the sufficient amount of grazing now available for the gaddi. For the first year or two, it would probably be necessary to give it to him free to accustom him to its use. It would be spread on

empty fields, for the sheep, who would thus also manure them. At first, the cost of these operations would have to be borne by Government and the supervision of the work by an officer of the Forest Department or Agricultural Department would be necessary. The hay field could be grazed over as usual by the incoming herds, save only that in cases where the excessive grazing of past years had so eroded the soil, its complete closure for a year or two might be necessary. If successful, such closures should result in largely increased fodder supplies, derived from comparatively small areas of land : and would tend to the introduction of stall-feeding, the improvement of the stock, and automatically curtail the misuse of the enormous areas of bare hillsides now grazed over

7. Conditions in Kangra, curiously enough, are to a large extent analogous to those which formerly prevailed in the Scottish Highlands In both countries, the flocks are driven down to lower pastures on account of the severity of the winter. In former days, when flocks were comparatively few in number and cultivation was limited, the Scottish herds grazed more or less at will in the valleys, as do those of Kangra at the present day. With the increase of security of property, increase of flocks and consequent rise in land values, this wasteful nomadic grazing gradually gave place to artificial feeding coupled with grazing in enclosed fields which are leased to the Highland flock owners during winter. Such conditions are beginning to arise in Kangra, and it is to cope with them that the measures outlined above have been proposed.

(ii) Forest Closures.

8. A considerable number of these have already been made, but owing to opposition on the part of the people it has not been possible to bring more than a small portion of the valuable pine forests under systematic management. It is suggested that it might be possible to accomplish more, if the principle that every

closure should contain an area sufficient to produce at least as much fodder as the formation of the closure had restricted, were adopted. In other words, the forest and fodder interest should be dealt with co-operatively, on the basis that there is plenty of room for both.

The majority of villages affected would be small hamlets interspersed between such areas of forests as remain. The constitution of these, as of similarly situated villages in Kulu as forest villages, on the following lines is suggested :—

I.—That where small villages surrounded by district forest of sufficient actual or potential value to render their reservation worth while are found, these should be formed into forest villages. That is to say, that they, together with their cultivation and forest land, should be entirely included in Reserved or Protected Forest, the Forest Department having an absolutely free hand in collecting or remitting their land revenue.

II.—The Forest Department would demarcate existing cultivation under the guarantee that it would remain untouched.

III.—The Forest Department would guarantee—

(*a*) all forest produce required for domestic use (but not for sale) free, but to be taken only from areas specified by it ;

(*b*) grazing sufficient for existing village herds ;

(*c*) not to close more than 25 per cent. of the forest taken up to grazing at any one time.

To induce the villager to agree to these terms, the procedure would be on the following lines :—

(*a*) Any village accepting the terms offered would have 50 per cent. of the land revenue paid on cultivation remitted for a period of five years.

(*b*) As an inducement to co-operate in fire-protection a further 25 per cent. of the land revenue would be remitted on each year that the area closed for regeneration was not burnt.

(*c*) As further compensation for the curtailment of grazing, the Forest Department would guarantee to put 5 per cent. of the closure under a fodder crop such as Bauhinia, oaks and so forth. Such fodder to be lopped free of charge by the villagers.

(*d*) To safeguard the interests of the villager one of their own men would be appointed as a forest guard on the usual pay.

In return for these concessions each village would agree to allow its unclassed forests to be worked under the usual system of rotational closures, and each householder would be required to give a minimum of 50 days' labour a year in forest works, such labour being paid for at the usual rates. The forest guard of the beat would be responsible for producing this labour. In point of fact, most of the villages which would be included in such a scheme give the Forest Department more than this amount of labour voluntarily.

9. The application of these conditions in an ordinary hill village to which such terms would be offered is exemplified by the village of Khola in the Kangra Tahsil and District. (I would note that this village has been taken merely at random and that there must be many others in which conditions for the application of these proposals would be more favourable.) In any case the selection of villages to which these terms could be offered would necessarily lie entirely with the Forest Department.

It consists of the following :—

Total area of land	...	432 acres.
Comprising area of cultivation	...	20 acres (Rent paid = Rs. 40)
Do. Demarcated Protected Forests	...	326 ,,
Do. Undemarcated Protected Forests	...	69 ,,
Do. Ghair Mumkin	...	37 ,,
Total	...	432 acres.

The unclassed forest in this case is of the best class of Chir existing in the Kangra District. Its value may be taken at Rs. 16 per acre per annum (*vide* paragraph 3 above). That is—

	Rs.	Rs.
Credit		1,104
Debit—		
Remission land revenue (maximum) for first 5 years only	20	
Cost of guard's pay at Rs. 10 ...	120	
*5 per cent. of area under fodder crop ...	56	
Remission of 25 per cent land rent for fire-protection	10	
Total debit ...		206
Credit balance ...		898
*Less cost of establishment of above non-recurring expenditure of, say, Rs. 20 per acre ...		70

SUMMARY OF PROPOSALS.

The object of these proposals is mainly to insure that the land in question is put to its most economic use. The essence of the proposal is that it should be a mutual agreement to the mutual profit of both sides. If the terms now offered are not good enough, then let the Forest Department, subject to the financial advantages to be gained in each case, offer better ones. If no agreement can be arrived at, then the forest must be left *in statu quo*.

The object of this note is to represent as clearly as possible the economic waste arising from the present misuse of land now going on in Kangra. Certain suggestions to improve those conditions have been put forward. It is not to be hoped that they can be introduced directly in a wholesale manner, nor is it intended in any way to upset the settlement already made. All that is contemplated is that the Forest Department be allowed to

experiment with one or two villages in the manner suggested. If these attempts are successful, then a revised settlement on these lines may be considered.

J. W A. GRIEVE,

Conservator of Forests, Eastern Circle, Punjab.

Dated 29th February 1920.

FORESTRY WITH THE B. E. F.

BY J. D. MAITLAND-KIRWAN, I.F.S.

(Continued.)

The Forêt de Crécy was a large compact area stocked with beech, oak, and hornbeam and worked under the coppice with standards system. Portions of the area were in process of being converted into high forest, but all our work lay in the coppice with standards area. The standards were of beech and oak, but the coppice was composed largely of hornbeam, the hornbeam being such a far better coppicer than the beech that it appeared almost to have ousted the latter from the underwood. The rotation for the coppice was 36 years, and our work in this forest provided an example of the way in which many of the French forests were overcut during the war. Normally of course only one coupe in each coppice felling series should have been exploited annually, but one coupe would not have gone far. I do not know exactly how many coupes we were given at Crécy, but when I left we were cutting stuff well under 30 years old, and I believe that the French were prepared to give us if necessary coupes down to 21 years of age.

Although many forests were overcut in this way I was told that in some forests the heavy fellings necessitated by the war were welcomed, for owing to the lack of demand for material from those forests in pre-war years the fellings were behind hand, and there was consequently an accumulation of increment, the removal of which was very desirable. Whether this was actually the case or not I do not know, but one thing is certain, and that is that French Forest Officers must now be engaged on a drastic

revision of many of their working-plans. I discussed this question with one of the French Officers, and he told me that they would probably turn their attention in the first instance to the forests in the devastated areas.

I stated in my last article that Major Hellmuth was F. D. C. O. of Crécy forest, and that he had his own company of Canadians with him. There was one other officer in the company who acted as Adjutant and looked after the personnel while as A. F. D. C. O. I was given charge of all the forest work. in which Major Hellmuth gave me practically a free hand. The transport was provided by a R. E. Pontoon Park, which was however transferred to the Italian front soon after my arrival, and by a detachment of the R. A. S. C. comprising both Motor and Horse transport. The labour was at first provided by two companies of Scottish Rifles who were quartered in different villages in the forest. The Forest and Transport staff were in billets in Crécy village during the winter, but in the spring the Forest staff moved into huts adjoining the camp of the Canadian Company, which was situated in the forest a mile or two from the village. This was my first experience of billets in France, and I must say that they were most comfortable during the winter. The French were as a rule very courteous, although they cannot always have welcomed the invasion of their houses, and the smallest and most meanly furnished bedroom always contained a splendid bed which very often filled up at least half the area of the room. There are few things in the world more comfortable than a French bed, and it was the only place where one could be sure of being really warm during the winter. A few notes may here be given regarding the manner in which the forest was being exploited, followed by an account of the method or transport employed.

Forests worked under the coppice with standards system require perhaps more skill on the part of the axemen than any other class of forest, if the exploitation is to be a sylvicultural success, and Crécy was very much a case in point. The French were very proud of this forest and as the success of the regeneration depended largely on the proper trimming of the stools they

were very insistent, and rightly so, on the efficient performance of this operation. Great difficulties arose in this connection, as I shall relate further on, but when I arrived the work was being well done by the Scottish Labour Companies, who had been there some time and who had developed into expert axemen. Saw-timber, firewood, and charcoal were the materials most in demand from this forest, and a number of poles of various classes were also supplied. I found the work in rather a chaotic state, coupes being worked all over the place but no coupe being properly finished; in some all of the coppice had been cut but none of the standards, while in others all the felling was completed but a lot of material was still lying on the ground; but the most disturbing feature was that whereas all the standards which had been felled had been marked off into logs and fuel, and had been shown as such on the returns, they had not actually been converted. Thus although our forms showed that we had some thousands of tons of firewood on hand, as well as many thousands of cubic feet of saw-timber, yet we were quite unable to meet sudden calls for either of these classes of material, for the wood had not actually been converted into fuel, nor was it on roadside ready for transport, and the logs had been neither trimmed nor cross-cut and were therefore not ready for the saw-mill. For the first few months therefore I had to put most of the labour on to clearing up these old coupes, a heart breaking procedure because all the material lying in them had already been classed as out-turn, and there was thus no result to show for the work. The consequence was that for the first two or three months of my stay at Crécy the outturn figures reached a very low point. When new coupes were commenced I insisted on the standards being felled *pari passu* with the coppice, and on nothing being shown in the weekly forms as outturn until it was on the road-side actually ready for despatch, or, in the case of logs, until they were ready for transport to the saw-mill.

The exploitation was complicated by the fact that a large quantity of charcoal had to be produced each month The manufacture of charcoal had proved rather a problem in all

forests to begin with, as no one knew much about it. I was amused to find that there was a certain amount of jealousy between the various camps on the subject, each camp thinking that they, and they alone, could make good charcoal, and one or two of them actually claiming to be the inventors of the particular type of kiln in use. The kiln was none other than the ordinary paraboloid kiln, of which illustrations are given in text-books on forest utilization. Charcoal burning is not an easy matter at any time except to the professional, and it will readily be understood that the manufacture of large quantities thereof by entirely unskilled labour was fraught with serious difficulties. The difficulties were increased by the demand being so urgent that it was impossible to allow kilns to cool off gradually. They had to be opened as soon as the burning was considered to be finished, and to minimize the risk of the charcoal catching fire a large quantity of water had to be used which rather spoilt its quality. A "Charcoal Section" was eventually formed, consisting of two officers and some N.-C. Os to supervise the charcoal operations in the L. of C. forests, their functions being chiefly of an advisory nature.

The officer in charge of this section was convinced that by raking the kilns down evenly on all sides the charcoal could be extracted with a minimum amount of water, a gallon per kiln being, he said, sufficient, and theoretically I dare say he was right. He came to Crécy to show us how the work should be done, although as a matter of fact we had been making excellent charcoal for some time past. That did not mean however that there was no room for improvement, and the officer in question was not one of those men who are content to sit in their office chairs and theorize. We therefore gave him a warm welcome and told him that we were delighted to throw the responsibility for charcoal making on his shoulders for a time. The first day he started building the kilns and took the greatest pains to show the labour, which at that time was Chinese, how the work should be done. He was not too pleased next day to find that the working parties had been changed, and that he had to teach them all over again;

and when the same thing happened the third day I was thankful that the Chinese were not versed in the intricacies of the Scottish tongue and were thus unable to understand the somewhat incisive phraseology which this irate officer saw fit to employ. I shall say something about Chinese labour later, but I may here mention that we were always up against the same difficulty, namely that the working parties were constantly changed. I never really found out the cause of this. The O. C Labour Company would be asked to send the same working party to the same locality, and in spite of his issuing orders accordingly it was often found that a proportion of the party, and sometimes the whole of it, was composed of men who on the previous day had been employed on some totally different kind of job; nor was this phenomenon by any means confined to Chinese labour.

The kilns were at last built and lighted, and the O. C. Charcoal Section prepared to leave for another forest, but not before I had wrung a promise from him that he would come back and open the first few kilns himself. He returned accordingly and I agreed to meet him early one morning in order to see the work started, and to learn how by the use of one gallon only of water per kiln it was possible to extract the charcoal and cool it sufficiently to prevent it bursting into flames. In order to avoid any risk of accidents however I had two 400 gallon tanks full of water stationed besides the kilns. When day dawned the weather, I was delighted to find, was very propitious from my point of view, that is to say, it was about as bad as it could possibly be. There was a gale of wind blowing, and as soon as an attempt was made to open the first kiln a fire was only averted by covering it up again quickly. The Officer decided that it was not at all a fit day to open kilns, and that the ceremony should be postponed until the following day. The weather next day was, however, about the same, and although I was unable to be at the scene of action in the morning I hurried down in the afternoon to see how matters were progressing. I found that the Officer had departed in his car after having, as the men told me, opened three or four kilns and having used several hundred

gallons of water during the process! The fact was that in the adverse conditions under which we had to work the use of a large amount of water was unavoidable. The method of pumping steam into the kilns was tried but was not very successful, and was, I think, eventually abandoned.

I have said that the charcoal making to some extent complicated the exploitation. The kilns were built in the coupes, but being coppice coupes everything except the logs and the firewood required for charcoal making had to be brought to the coupe boundary, as the French would only allow the minimum amount of transport inside coppice coupes. It was therefore necessary to know exactly how much wood was required inside the coupe for kiln building purposes, and to ensure economy of labour this had to be stacked round the prospective kiln sites. We were not allowed to choose our own sites, and it was therefore necessary to get the French guard to allot them well ahead in order that the labour might know where to stack the wood. Another difficulty was that in coppice the French would not allow us to have a concentration of kilns on account of the damage which the burning of these would have caused the stools over an area of appreciable size, and the sites they allotted were as a rule one or two hundred metres apart. This meant a much larger number of watchmen than would otherwise have been necessary, and rendered supervision a difficult matter, especially at night. We eventually gave up making charcoal in the forest, and had a large concentration of kilns in a field near one of the railway stations. This entailed the carriage of some thousands of tons of fuel from the forest to the site, a distance of three or four miles, and also of many lorry loads of leaves for covering the kilns, but all things considered the arrangement was in every way a more satisfactory one.

To sum up then, the actual work of exploitation was carried out somewhat as follows. A line of men would go on in front felling the coppice and piling it neatly. Behind them would come other parties who would convert the already felled stems into poles, pickets, fuel, or whatever was required, and stack them

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according to their proper classification along the coupe boundary except in the case of fuel for charcoal, which would be stacked in the coupe in the neighbourhood of kiln sites. Some distance behind these parties would be another line of men whose duty it was to fell the standards, and behind them again would be other parties to convert the standards into whatever class of material was required, to cross-cut the logs if necessary, and to make the crooked pieces into fuel. Their business was to clear up the coupe so that not a single piece of wood was left lying about, and so that no subsequent cleaning up operations should be necessary. All these operations were supervised by checkers from the Canadian Company working under the orders of the A. F. D. C. O. Their duty was to see that the work was of the proper quality, to measure all the stacks of fuel, poles and pickets, to calculate the cubic contents of the logs and to mark them off for cross-cutting, and to keep a complete record of the work done. The work of exploitation was of course carefully watched by the French staff, and no coupe could be commenced unless the local "Brigadier" or Ranger had been given due notice. We were provided by the French with detailed estimates of the outturn from all coupes, and if the actual outturn differed from the estimate by more than 25 per cent. we had to give some explanation. As a matter of fact the estimates were usually very fair, and our outturn more often than not exceeded them. Weekly returns showing the progress of exploitation and the amount of material on hand, as well as countless other returns, had to be sent to headquarters, and a coupe book had to be kept showing the dates of entering and finishing coupes, and comparing the actual outturn with the French estimate.

When a coupe was finished we used to inform the Maire of the village of the fact, in order that he might allow the villagers to go and glean in it. It was extraordinary the amount of material they used to get out of it, for they would take away even the smallest faggots, and bind the brushwood into bundles for use as fuel. Unfortunately the French used to do a considerable amount of gleaning on their own in coupes which were

by no means finished. They all knew which were the coupes allotted to the English, and we used to see them waiting with wheel barrows, and sometimes even with carts, ready to swoop down on the coupes as soon as the British labour knocked off work. One day I even found an R. A. S. C. Driver permitting the villagers to load his waggon with their "gleanings," a fine exhibition no doubt of the spirit of the Entente Cordiale, but I thought it was going a bit too far. We tried in various ways to put a stop to these illicit operations, but never with the least success as far as I could see, and what one could not stop it was best to wink at.

If an efficient method of exploitation was important a well organized system of transport was not less so, and a few notes on the subject may be of interest.

Three methods of transport were employed in the L. of C. Forests, Horse, Motor, and Railway transport. The H. T. at Crécy was supplied during nearly the whole time I was there by the R. A. S. C. Horses were used for two purposes, firstly for transporting the material from the interior of the coupes to the nearest point where it could be picked up by lorries, and secondly for hauling logs to the mill. In the first case teams of horses were usually harnessed to General Service waggons, the drivers sitting on their horses and the whole thing being done in the most approved military style. This work was often very hard on the horses, for after heavy rain the waggon wheels used to sink in up to their axles, and the loads brought out under these circumstances were necessarily small. Under such conditions we used to think that it would have been better if the drivers had dismounted and led their horses, but I suppose this would have savoured too much of civilian practice. For bringing logs to the mill either Canadian carts or "Devil Carts" were used. Canadian carts were low four-wheeled waggons without any sides, and were useful for the carriage of moderate sized logs which had been cross-cut, while Devil carts were carts with two large wheels, and were employed for heavy or very long logs which were fastened between them by an arrangement of chains. For especially long

logs a French type of Devil cart, called a "Binard," was used, the logs being raised off the ground by a lever attached to the top of the carriage. Skilled labour was required to load these Devil carts, and parties had to be trained for the work and kept continuously on the same job.

Motor lorries, although sometimes used for carrying logs to the mill, were at Crécy employed chiefly in conveying poles, charcoal, fuel, and other material to the station. I have mentioned in a previous article the fact that as the O. C., R. A. S. C., had to serve two masters, friction sometimes occurred. The sole object of the Forest staff was of course to get the work done, while the great aim of the R. A. S. C. was to be able to show the maximum number of ton miles per day or per week, or in other words to show that they had carried as heavy a load as possible for every mile travelled. The object of course was a laudable one in so far as it aimed at the ecomomy of transport, but it was apt to be carried to extreme lengths. If, for instance, the work at the saw-mill was being held up for the want of some piece of machinery obtainable from our central Forest Stores at Buchy, some 60 miles away, there would be a complaint from the R. A. S. C. if I wanted to send a lorry for it on the ground that it would mean an empty journey one way and only a light load the other. Had the required bit of machinery been sent by train, however, it might have taken weeks on the journey and have held up the work for a corresponding period. This is an example of an extreme case, but the same principle always held good, and led to complaints on both sides. If I wanted a dozen trucks filled with fuel at the station, and ordered four lorries for the work, there would be complaints from the O. C., R. A. S. C., if the work was over early, on the ground that more lorries than were really necessary had been ordered, whereas if I instructed him to get the trucks filled and to supply as many lorries as he thought necessary he would, if he failed to get them filled in time, lay the blame on my loading parties for working slowly and keeping his lorries waiting. There would be counter-charges from the loading parties that instead of the lorries being properly distributed and arriving

at decent intervals they had all come at once, and that naturally some of them had to be kept waiting while the others were being loaded. This constant friction was the fault not of the men but of the system, and the Canadian Forestry Corps was very wise in having its own transport, and thus avoiding duality of control.

The lorries were of course very hard on the roads and this caused us a good deal of anxiety during the bad weather. Road repairs were constantly going on, those to the chief main roads being carried out under the supervision of the Roads Directorate, the labour being supplied by us, and very often the metal as well, and the minor roads being done entirely by us, stone for the purpose being fetched by the lorries from Cayeux, a little seaside village some 20 miles distant During thaws after very hard frosts no lorries were allowed to run, and we had to be prepared for emergencies of this kind by having big dumps of various classes of material at the different stations, so that our despatches would be interfered with as little as possible.

Railway transport included the Decauville light railway employed in the forest as well as the ordinary broad and metre-gauge railways. Very extensive use was made in the forests of Decauville railway, and it largely superseded Horse transport as far as clearing the coupes of light material went. Unfortunately, however, there never seemed to be enough of it, but what there was proved most useful The labour became quite expert at putting down and taking up the rail quickly, and officers became proficient in deciding the best position in which to lay the line so as to tap the areas under exploitation as fully as possible. The trucks were as a rule propelled by man power, but sometimes, and especially on steep gradients, horses were used. There is no doubt that light railway of this kind has not been used in India as largely as it might have been, and this is due no doubt to the fact that our exploitation is chiefly carried out by contractors. It would, however, probably be beneficial to the department to induce contractors to use it, and if necessary to supply them with a certain amount at first in order that they might have an opportunity of proving its value. My only experience of

civilian labour in France was in the Forêt de Roumare, where we gave a contract for the exploitation of some coupes to a Frenchman, but provided him with a considerable length of rail and a sufficient number of trucks. Having given him his transport we were in a position to insist on the exploitation being carried out with all speed and the material extracted as the work progressed.

Crécy Forest was served by three metre-gauge railway stations, and the saw-mill also adjoined a station. Loading was carried out at these stations daily, but rolling-stock was sometimes very difficult to obtain, and although I used to visit the Chefs de Gare every evening and tell them my requirements for the following day I was never certain that they would be fully met. Major Hellmuth, who had had considerable railway experience in Canada, soon made up his mind that the most economical system of transport would be to construct a feeder line running through the forest, with one or two branches to tap the various coupe areas. This would to a great extent do away with the lorry traffic, and would enable the timber to be loaded into railway trucks at the coupe boundary instead of first being put into lorries, then perhaps dumped at the station, and finally loaded into trucks. Moreover it would ensure the regular despatch of material in winter when sometimes owing to deep snow or hard frosts the lorries could not work. There were also other advantages connected with the project, which was eventually approved, but to get a project approved and to get it carried out are, in the British Army, two very different things. First of all various people had to come and inspect the proposed line. One of the advantages expected from it was that it would do away with the congestion of transport of all kinds which crowded the road leading to the mill, and in order that there might be no doubt about this congestion Major Hellmuth ordered me to turn out all the transport in the forest, and to see that the greater part of it happened to be passing along the mill road about the time the inspecting officers were due to arrive. The transport entered into the fun of the thing, and Devil carts and motor lorries were jostling each other for room when eight car loads of staff and other officers drove

up. They all got out and stood about, some of them apparently trying to look as if they had not come merely for the joy ride, and then they all drove off again. Other officers came to inspect the proposed line at intervals, and in this matter, as in many others, those two great army principles to which I drew attention in my first article, namely the avoidance of the obvious course and the paramount importance of delay, were strongly marked. The obvious course would have been to tell Major Hellmuth to construct the railway and to do so at once. He had already built one railway through a French forest, and his Company contained all the engineering personnel necessary for operating it. What as a matter of fact the authorities did do was to tell the R. E. to construct it and to arrange for the French to operate it and to require Major Hellmuth to do nothing at all except provide the labour from the Labour Companies in the forest. I believe the French eventually agreed to our running it, but the net result of the weighty deliberations of the staff was that instead of being built at once the line was not ready for use until long after the winter, when the urgent need for it was gone.

Closely connected with the exploitation and the transport was the task of detailing the working parties, which had to be done by the A. F. D. C. O. every evening. The various parties for felling, charcoal making, saw-milling, road work, camp construction, etc., had to be told off, and copies of the orders sent to the O. Cs. of the Labour Companies concerned. Arrangements had to be made for the supply of drinking water to all these parties and for hundreds of gallons of water for the charcoal kilns. The O. C., R. A. S. C., had to be informed of the quantity of material which had to be brought to the roadside, to the mill, and to the various railway stations, and loading parties had to be arranged for in each case. Various other details of the next day's work had to be settled, and to enable this detail to be made out successfully an intimate knowledge of the daily progress of the work was required; I had therefore to be round the forest in my side-car most of the day. Not only had the detail to be

made out correctly, but it was necessary each morning to see that the working parties and transport were duly supplied, for mistakes frequently occurred and had to be rectified by personal interview or telephone. There was an excellent system of telephones in all the forests I saw, and it seems a pity that this system is not more extensively employed in Indian forests.

Having given a general idea of the work in Crécy forest I will now deal with one or two special points of interest.

The policy of replacing all white labour in the back areas by Chinese or German prisoners soon affected us, and we were warned to prepare for the advent of two companies of Chinese labour. The Scottish Labour Companies had been living in billets so two complete camps had to be constructed for the Chinese in different parts of the forest. At first barbed wire compounds and tents for the coolies and a few wooden huts for the officers were all that we could provide, but very fine camps were eventually built.

The Chinese Base at Noyelles was only a few miles from Crécy, and it was a simple thing to move the men over. Day after day we were told that they were coming, only to be told again and again that their arrival had been postponed, and the authorities eventually chose to send them on Christmas day, probably because that was the obvious day on which not to send them. Of course the move gave every one a lot of extra work, and as we were eating our Christmas dinner, to which we had been invited by the Canadian N.-C. Os. and men, the Chinese were streaming into the camp on all sides. We managed however to get in a sumptuous repast of goose and plum pudding, this being followed by many after-dinner speeches. I remember saying that whereas the previous year I had spent Christmas in India it was difficult to decide from appearances on the present occasion whether I was spending it in Canada or China.

The Chinese were quite new to forest work, and the task of training them was not an enviable one. I shall never forget the first few days of coppice felling or the revengeful expression on the face of the French Forest Guard as he watched the work

of devastation proceeding Several Canadian axemen were allotted to each felling party in order that the Chinks might see how to use an axe, but it was heart-breaking work, and our output fel almost to zero, much to the astonishment of Headquarters, for had they not supplied us with two companies of labour in place of the two which had been removed? After a time, however, the Chinese became most excellent workmen, and better coppice felling than they did I have never seen anywhere. Of course when they had become thoroughly expert they were sent away somewhere else on some entirely different kind of work but the excellent work done at Crécy by "Les Chinois" will be long remembered

The Chinaman proved a capital workman on three conditions: firstly he had to be properly handled, secondly, he had to be put on task work; and thirdly, he had to be well fed. Of the two companies sent us one proved very unsatisfactory and the other became the best Labour Company I have ever had anything to do with for the simple reason that whereas the first had a weak O. C. the second was commanded by an energetic Australian Officer who, although he treated the men very well and took great pains to make their camp thoroughly comfortable, yet showed himself to be a rigid disciplinarian, and enforced discipline in a manner which may have been somewhat at variance with the regulations in force, but which was thoroughly understood by the Chinese. The Chinaman can be a somewhat truculent fellow when he likes, and some of the Labour Company N.-C. Os. who were supposed to control the work, although they had no previous experience of controlling labour of any kind, frankly told me that they were afraid of them. I once saw one of these N.-C. Os. write down on a piece of paper the number of a Chinaman who had not been working properly, with a view to reporting him. Instantly the whole working party surrounded the wretched man and by threatening him with their axes compelled him to tear the paper up.

The coolies worked very slowly if they were employed on day work, but if they were set a task the change was so marvellous

that before proper schedules of task work had been drawn up it was practically impossible to know how much they could really be expected to do. Closely connected with their work was the question of their rations. I have no idea how much they got, as that was entirely the concern of the Labour Officers, but however much it was it never seemed to be enough. They used to have a meal in the forest, in addition to copious draughts of very weak hot tea, and when they thought it was about time for this they would show a decided disposition to stop work, and would keep on calling out "Chow-chow." If they considered that they did not get enough food they simply refused to work, and no power on earth could make them. When inspecting the coupes I used frequently to find working parties standing idle and patting their stomachs, and calling out in a mixture of Chinese, English, and French "Chow-chow no bon." This was very disconcerting, and we used to try and get the Labour Officers to prevail on their Directorate to allow the men better rations. They tried to explain to them that their food was really ample, but that it was in a concentrated form; that although the quantity might *look* small it was not really so, for it expanded in a marvellous way when it got inside them. This however did not satisfy the Chinaman, what he wanted was bulk, and he liked to feel it going down!

In addition to the ordinary Labour Companies we used to get a number of convalescents over from the Chinese Base by lorry daily. These men were only fit for light work, and some of them were hardly fit for that. Among these convalescents were a number of lunatics, and I remember once inspecting a party of some 30 men and remarking to the Officer in charge that the work did not seem to be progressing very fast. He complained that all but three of his party were lunatics, and that it was very difficult to get on with the work when some of them kept proudly strutting about, each imagining that he was the Emperor of China, while another positively refused to do anything except wander about and eat all the snails he could find!

The Chinese coolies were worked by native gangers, the whole lot of course being under the control of the Labour Officers and N.-C. Os. Native interpreters were provided, and two qualifications appeared to be necessary for this post, the first being that the man should be unable to speak English, and the second that he should be unable to speak Chinese, or at any rate the dialect of the particular company to which he was attached. Of the Chinese as a whole it may be said that if properly handled and fed they were a cheery, willing, and hard-working crowd, and we were very sorry when they went. They were physically very strong, and I doubt if better labour exists anywhere in the world

The period of Chinese labour in Crécy forest came to an end with the launching of the great German offensive on the 21st of March 1918 That offensive, as all the world knows, had far-reaching results, and it stirred to its depths even so peaceful a backwater as Crécy forest Its effect on our work was immediate, but I must defer to my next article an account of the changes which it brought.

(To be continued)

THE CONIFEROUS LUMBER SUPPLY AND TRADE OF THE N.W. HIMALAYAN FORESTS OF INDIA.

A recent enquiry elicited the fact that the river timber depots on the big rivers of the Punjab and the United Provinces, from Nowshera Depot on the Indus River on the west to the eastern depots of Kathgodam and Tanakpur, supply annually some 13¾ million cubic feet (260,000 tons) in log and in scantling to consumers. This figure of course does not include smaller markets reached by road, local consumption, and losses and theft in river transit Probably 10 per cent. could be added to allow for these items in order to get a more accurate figure of annual demand. However, the figures given must necessarily be rough until the forest department intelligence branch is considerably better equipped and organised and closer co-operation with the timber

trade is established. The coniferous timber species concerned in the enquiry were silver fir (*Abies Webbiana* and *Pindrow*), spruce (*Picea Morinda*), deodar (*Cedrus Deodara*), devi-diar (*Cupressus torulosa*) blue pine (*Pinus excelsa*) and chil or chir pine (*Pinus longifolia*). This investigation led to the next in natural sequence, namely a detailed study of areas of forests under each of these species, containing merchantable timber, possible output under present conditions and probable output under intensive management The study involved a scrutiny of available working-plans, annual reports and special reports, aided by twenty years' personal experience of many of the areas concerned The summary of facts ascertained may not be without interest to Indian foresters and in giving it the writer hopes to stimulate interest in the subject of systematic and comprehensive surveys of Indian forest resources. Without such surveys industrial expansion and the creation of forest industries must be based on rough visual estimates of available raw materials, and this is a process most business men would turn down as not good enough and as far too haphazard where lakhs of rupees are to be invested in machinery and plant for a projected factory, say, for pulping, cooperage or match making, to cite a few instances of schemes now under investigation at the Forest Research Institute, Dehra Dun. The last Board of Forestry had its attention drawn to the subject in a forcefully worded paper by Mr. Raitt, the pulp expert to the Forest Research Institute and what follows is an attempt to appraise the lumber possibilities of the N.-W. Himalayan forests.

Taking all the above conifers together, the first fact that strikes one is that the total workable area is 8,650 sq. miles (say 5½ million acres) This is not a very vast figure when one thinks of the 200 million acres of pine forest in British Columbia or the 90 million acres in the province of Ontario, and strong justification will be required before embarking into new industrial enterprises which make huge inroads into forest supplies, as for instance pulping. Nevertheless the Indian area without great developments in forest working can yield about 23¼ million cubic feet

of timber annually (say 460,000 tons), while under intensive management and in a reasonable space of time this yield could be raised to a sustained annual output of 60 million cubic feet This last figure is rather less than half the quantity of timber required for railway sleepers were the whole of the Indian railway tracks furnished with wooden sleepers. As it is various types of iron sleepers reduces this figure considerably, but the illustration visualizes what the quantity available can accomplish

Of the 8,650 miles of forest under discussion only one third is under the control of the Forest Department, while two-thirds belong to Indian States, the Jammu and Kashmir State with the adjoining Bhadarwah 'Jagir' claiming most of the latter. Fortunately the rulers of these Indian States are very much alive to the value of their forest properties and an enlightened and progressive forest policy may be counted on.

To come to details :

In regard to the silver fir and spruce forests the total workable area, as far as present information goes, can be put at 2,920 sq. miles say 1,860,000 acres). That is, it represents about one-third of the whole area under review. The Punjab Forest Department controls 764 sq. miles, Punjab Indian States 1,959 sq miles, U. P. Forest Department 37 sq. miles (though possibilities in Garhwal and Kumaon are at present not well known) and U. P. Indian States 160 sq miles

The timber trade does not differentiate at all closely between fir and spruce timber. The present supply of both species is approximately 1¾ million cubic feet (35,000 tons), Wazirabad on the Chenab River being the biggest centre of supply with Jhelum a close second.

These fir and spruce forests are practically virgin forests and can yield close on 7 million cubic feet of timber a year without any great forest developments, while the yield is capable of an increase to 18 million cubic feet under fairly intensive conditions of working. The forests should be able to give a sustained yield of something like 90 million cubic feet a year, when the normal forest stage is approached, for though that is frankly

looking far ahead yet it is borne out by the heavy crops now met with, often over 50 trees per acre of 5 feet girth and over (say 5,000 cubic feet per acre) There is no danger of the market not keeping pace with the supply, as large quantities of timber of these species will be required annually for creosoted sleepers, while any match industry in order to supply only India would require 4 million cubic feet of these timbers a year.

From the least worked coniferous forests of the N.-W. Himalayas one has next to turn to the heaviest worked, namely, the deodar area. In this category one has to include the comparatively small tract of devi-diar forest as the timber trade does not scruple to sell the latter as deodar. The workable area of deodar forest in the N.-W. Himalayas is 2,010 sq. miles (say 1,280,000 acres) and the current annual receipts in timber depots of deodar timber is just over 5 million cubic feet (100,000 tons), which can be raised to 6 million cubic feet as soon as more intensive management is introduced. Later, when modern working-plans gain the ascendancy, working-plans of the type recently completed for the Kulu Forest Division by Mr. C G. Trevor, one can forecast a maximum supply of at least twice the latter quantity, that is 12 million cubic feet. Should creo-spruce and creo-fir sleepers replace deodar an export of deodar timber may be possible, but it is more likely that the ever-increasingly prosperous canal colonists of the Punjab will absorb all that is offered in the Indian timber markets.

As in the case of the spruce and silver fir forests the greater part of the deodar zone lies within Indian States, mainly in the Punjab The Punjab Forest Department only controls 158 sq miles and the U P Forest Department 90 sq. miles, the rest, 1,762 sq miles, is State Forest, of which 50 sq miles lie in the U. P.

These figures show the necessity of controlled scientific forest management in the Indian States of the N.-W. Himalayas, and as already stated they are generally alive to the necessity and have placed their forests in the charge of Imperial and Provincial Forest Officers lent by the Indian Government.

The next conifer to be considered is the blue pine. It grows pure over large areas, but often in admixture with the deodar, so the determination of its area is a little difficult. Besides it is spreading very rapidly as the result of systematic protection mainly from fire, so much so that blank areas and bare hillsides of 15 and 20 years ago are now covered with dense crops of saplings. Perhaps no timber has found favour in the timber trade as fast as the blue pine. Next to worthless in 1895 it now fetches two-thirds the price of deodar. Added to that one has to note exceptionally fast height growth, often 4 feet a year, and rapid radial growth, five or six rings per radial inch. The working of *P. excelsa* intensively on a rotation of 80 years can be foreseen and thus it becomes a very valuable source of coniferous timber supply.

The workable area is not large at present, 993 sq. miles (say 635,000 acres) mostly in Indian States, viz., 654 sq. miles, all in the Punjab, according to present available information. The Punjab Forest Department controls 287 sq. miles and the U. P. Forest Department 52 sq. miles The annual supply of timber of this species reaching the timber markets is already 2¾ million cubic feet (55,000 tons). An early increase to 4½ million cubic feet is probable, while extensions of area and intensive management brings a yearly output of 12 million cubic feet well within the realm of reasonable attainment.

The last belt of forest, and also the second most extensive, is that covered by the chil or chir pine, *P longifolia* This species has already been closely studied and Mr. R. S Troup's excellent forest memoir on *P. longifolia* is a model of its kind and the precursor, it is hoped, of equally good studies on the other principal timber trees of India.

The workable area of chil pine is about 2,709 sq. miles (say 1,730,000 acres), fairly equally divided between the Punjab and the U. P., the U. P. having secured a magnificent forest property, as the following figures will show

Area under Punjab Forest Department	254	sq. miles.
Area in Punjab States ...	.. 1,082	„
Area under U. P. Forest Department	... 1,203	„
Area in U. P. States ...	... 170	„

P. longifolia timber is probably the strongest Indian coniferous timber and may aptly be named the "Indian Oregon Pine." It has a ready and rapidly expanding market, 4½ million cubic feet being the present approximate annual supply, or 85,000 tons, a yield which can be raised to 6 million cubic feet almost at once, while intensive management may easily treble or quadruple this figure, or to be on the safe side, say 18 million cubic feet a year.

Such are the figures revealed by an analysis of the coniferous timber resources of the N.-W. Himalayas. They are rough, but they are sufficiently accurate to enable one to get a good idea of what India can obtain from this source of timber supply. The benefit of knowing this is twofold, it enables one to formulate schemes of industrial expansion with some accuracy and it enables one to frame some sort of an estimate of the capital value of this forest property and to determine whether the financial return obtained and obtainable is adequate or inadequate. Forest finance is a big subject and one badly neglected in India up to date, but the question cannot be discussed here.

To sum up, the forest tract under review is now yielding 13¾ million cubic feet of timber annually, the yield is capable of early expansion to 23½ million cubic feet, while intensive scientific management may be expected to bring it up to 60 million cubic feet a year, the U. P. and the Punjab Forest Departments controlling about one-third of this output, with a value of at least Rs. 15 million, *i.e.*, Rs. 1½ crores.

There is no reason why imports of foreign pine timbers into India should not be brought to a standstill, if only the Forest Department will study the reasons for such imports. The principal reason is size. The Indian consumer not being able to get Indian pine timber of the required length and sections buys the foreign product meeting his requirements. Improved lumbering and transport methods in India will, it is hoped, alter this and save for India the many lakhs of rupees now leaving the country annually in payment for imported pine timber.

Another point to which attention has to be drawn is the imperative necessity to get the maximum volume of timber out

of each felled tree to the market At present conversion from log to scantling in the forest is so wasteful that 50 per cent. of the tree is left to rot there, increasing the fire risk and making the forester's task of obtaining natural regeneration infinitely harder. Conversion must be in log and the log must be transported to the market, where every portion of it has a value. This policy will entail increased expenditure on lumbering but most foresters nowadays realize that to increase revenue one has to increase expenditure, so the point requires no elaboration. The elimination of waste in the handling of its forest resources must in future be one of the first aims of the Forest Department, if an adequate rate of interest on the capital value of the Indian forest property is to be earned and besides natural resources have their limits and the Himalayan coniferous timber supply, as this note clearly shows, is no exception.

It is not a very difficult calculation to determine how much capital expenditure can be borne by an enterprise to improve transport facilities, by land and by water, in order to get a fair return on saving and marketing that 50 per cent. of timber now lost by conversion in the forest.

At the main entrance of the Forest Products Laboratory, Madison, Wisconsin, used to be a mural tablet, on which appeared in letters of gold :—

"Estimated value of forest products U. S A. 1909	$1,250,000,000
Approximate wastage in production of all forest products	50%

The Forest Products Laboratory

Deals with reduction of waste and increased efficiency in the utilization of forest products."

The Indian Forest Department can do no better now that it is emerging into the money-making stage, than adopt as one of its principal working rules the utilization of its products to the utmost coupled with the elimination of all preventable waste.

In conclusion attention is again invited to the main object of this note. It is the crying need of the department to ascertain as accurately as possible the extent of Indian forest resources by means of systematic industrial surveys, so that when the demand arises the Forest Department may be in a position to meet the demand with accurate information in regard to sources of supply, quantities available and cost. Till this is done the Forest Department will have failed to earn its designation of being even a "quasi-commercial" concern.

A. J. GIBSON,
I. F. S.

KING-EMPEROR'S BIRTHDAY HONOURS' LIST, 1920.

We are glad to see that the following members of the Forest Department figure in the recent Honours' List :—

COMPANION OF THE INDIAN EMPIRE.

Ralph Sneyd Pearson, Esquire, Forest Economist, Research Institute, Dehra Dun.

KHAN SAHIB.

Malik Allah Yar Khan, Extra Assistant Conservator of Forests, Punjab.

RAI SAHIB.

Mr. Lak Singh, Extra Assistant Conservator of Forests, Damoh, Central Provinces.

PASSING EVENTS.

The announcement of the resignation of Mr. H. S. Graves from the highest post in the United States Forest Service is of more than passing interest to us in India.

Mr. Graves has filled the post of Forester for ten years with distinction. With a fine grasp of the subjects of his profession a wide outlook and a clear literary style he has elevated his Service, enlarged its scope, particularly in the direction of scientific research, and kept in close touch with the more far-seeing members of the lumbering industry.

Many of us realise what a preponderating influence lumbering interests have on the continuity of the forests of North America,—that much more than half of the richer and easily accessible woods, land as well as timber, are privately owned and that these woods are being cut over and destroyed with startling rapidity. Of 800,000 sq. miles of forest land in the U. S. A. one-fifth has been laid waste, that is to say felled over and burnt with no present hope of the regeneration of tree growth and with no systematic devotion of the land to other useful purposes. Furthermore the remaining woods are being cut over at about three times the rate at which they are putting on increment thus tending to their exhaustion within an appreciable time, and this in a country of comparatively sparse and rapidly growing population. Where wood has been so plentiful the individual consumption for all purposes is very great,—more than twice as great as in Europe where again all the Western nations (even France and Germany) import more than they export. Again, cutting without replacement of the forest crops in successive regions on this huge scale leads to undesirable movements of the population which is dependent on the lumber industry and helps to force up the price of timber and wood products all the world over.

The U. S. A. is a democracy and one of the chief works of the Forester and his fellow workers all along has been to try, through the circulation of the newspapers and other forms of publication, to educate the public in clear thinking regarding the vital necessity of the continuity of the forests to the nation. Indeed one of the reasons of Mr. Graves' resignation now is in order that he may further a campaign, begun a year ago, for the better combined handling of all the forests of the country.

Mr. Graves and his successor Mr. W. B. Greeley were successively in command of the forest work of the American Expeditionary Force in France during the great war. The enormous value of the forests to the principal belligerent nations, both for use and for defence in war, was one of its most striking lessons and can never be forgotten by the leaders. Probably no one, except an occasional idealist, believes that the world has seen the last of

war. A nation with insufficient or badly located woodlands may well start the next serious campaign under a grave handicap.

Hitherto the conditions of government in India have been favourable to the restoration of its much damaged forests and over large areas the appearance of a new crop is enabling us to remove the overwood in a more rapid and concentrated fashion than was possible formerly. Provincial revenues are being swelled from this cause and by reason of the rise in prices of the raw products of the woods. We are better placed than the U. S. A. to this extent that we have been favoured by a long period of comparative rest which through careful treatment has assured the continuity of the forests in large part. That time is perhaps passing, politics may by expected to enter our domain very soon and we who believe in the necessities of regular forest management (as what forester does not ?) shall surely be called upon to prove our belief. We have good facts and figures to rely upon, the improved condition of the woods as our witness, but while we need not be nervous of the unaccustomed position we shall do well to come out of our retirement and be ready to talk with our neighbours and make good our case in a similar way to that employed by our fellow foresters across the Pacific Ocean, a study of whose methods may well prove useful at this time. Present events in the U. S. A. indeed give us ample food for reflection.

EXTRACTS AND REVIEWS.

RESEARCH WORK INTO FOREST PRODUCTS IN OTHER LANDS.

BY I. H. BOAS, M.SC.

Forest products enter so largely into important industries that isolated investigations into their possibilities have been made in most forest countries for a considerable period. This applies particularly to such industries as paper-making, which consumes enormous quantities of timber. It is, however, only within the

last decade or so that systematic investigation in centralized laboratories has been undertaken into the many other timber-using industries, and into possibilities of utilizing the varied minor products yielded by forests.

In this work America has led the way, by the establishment of forest products laboratories, and also by enabling the staffs at the Forest Schools to undertake research. In some of these schools for example the staff is sufficient to enable each member to spend two terms in teaching and the balance of the year on investigation. This splendid arrangement keeps the staffs always up to date, and reacts most favourably on the teaching work. It also has resulted in much valuable research being carried out.

For example, in the Forest School at Seattle, the staff has done valuable work in timber preservation, timber seasoning, and in other directions. Some of the work directed to specific problems affecting local industries, and some is of a more general character. Professor Grondal, of Seattle, has developed a method of seasoning low-grade timber in twenty-four hours, without causing any loosening of the knots. Such low-grade timber must be treated quickly, for its value would not bear the cost of the usual slower processes. At this University there is also a complete timber-testing laboratory, at which splendid work has been done, especially in demonstrating the possibilities of Douglas Fir (Oregon Pine). This investigation proved of particular value during the war, when stocks of seasoned spruce were unobtainable, and Douglas Fir was shown to be fit for purposes for which spruce had been formerly considered essential. There is a very beautiful Forestry Museum at the Seattle University, built of whole logs of this beautiful tree.

In the United States of America there are several other Forest Schools where similar research work is done, but the main investigations are centred at Forest Products Laboratory at Madison, Wisconsin. This laboratory is under the control of the Federal Forest Service, but is attached to the University of Wisconsin, which provided the site and some of the buildings. The Laboratory is quite free from University control, but members of its staff give

courses of lectures to students, and senior students can arrange to do research in the Laboratory For a few years the institution had a staff of about forty, but this grew rapidly as its work became known, and during the period of the war 450 workers were busily engaged in laboratories occupying ten large buildings. The war work of the Laboratory was of immense value, not only to the various war activities, but to other industries. A practical evidence of this value was shown by the fact that when Congress threatened the Laboratory grant in the general rush for post-war economy, all the trades, which had benefited by its work, bombarded Washington with urgent demands that the grant should be adequate. The result was that the post-war grant is sufficient to keep a staff of 250 workers employed.

One of the principal activities of the Laboratory has been a most complete physical survey of the principal commercial timbers of the State. In this monumental work hundreds of thousands of measurements have been made, and a staff of thirty women graduates was kept busy calculating the results from the measurements of the investigators.

There is a direct practical value behind these inquiries The Laboratory is in a position to advise trades that utilize timbers as to what materials are suitable for their particular requirements Some interesting results followed on the re-drawing of War Office specifications for boxes for munitions of war, by the Laboratory staff A saving of 25 per cent. in the cost and 33 per cent. in space occupied was effected. The money value of this slight modification alone ran into hundreds of thousands of dollars during the war Other directions in which the Laboratory has obtained valuable results are in timber preservation, timber seasoning, prevention of decay of timbers in buildings, prevention of timber diseases in the forests, the utilizing of timber waste, the introduction of new sources of timber for paper-making In these and many other matters the staff of the Laboratory keep close touch with the industries, and a field staff is employed to advise factories, and to bring in new problems of a practical nature for solution. Anything approaching a complete account of the work done in

this splendid institution under its able Director, Mr. C. P. Winslow, would occupy more space than is available for this article. Sufficient has been said to indicate the scope of its functions and the value of the results obtained. If Australia can establish a laboratory which, even distantly, approaches that of Madison, there can be no doubt that whatever money is spent will be repaid many-fold. So far from not being able to afford the cost of establishing and maintaining such work, Australia, with its large forests and its huge waste, cannot afford to neglect the pressing need to survey the wide field of research into forest products.

Canada followed the splendid example of the United States by establishing a similar laboratory at Montreal, in conjunction with the McGill University. While this institution has not received the same generous endowments as that at Madison, it has been given a fine equipment, and has done a great deal of work of recognized value. One of its main features is the excellent paper laboratory, with its large machine for making paper on a semi-factory scale. Unfortunately, the Government of Canada has not paid the investigators sufficiently large salaries to prevent the industries from tempting them into the industrial world. The paper trade has always recognized the value of the Laboratory, and has taken advantage of the practical experience obtained there by the workers. The consequence has been that, tempted by generous offers, many of the staff of the Laboratory have recently resigned, and much of the activity of the Laboratory has thus been hampered. Vigorous attempts are being made to overcome this difficulty. Only one way is open, and it is hoped that the Government of Canada will be able to see it, and take advantage of the opportunity that the Laboratory presents, to develop forest industries. A branch of this institution has been established in Vancouver at the University. This branch deals, at present, only with timber testing, much as does the Seattle branch of the Madison Laboratory.

In Great Britain there has been no attempt to carry on any kind of systematic research into forest products utilization. The forest areas are small, and this fact probably accounts for the

omission In a country with small timber resources there is really all the more need for preventing waste and the misuse of that timber and for insuring all its products are used to the greatest advantage. During the war much work was done in scattered institutions, particularly on testing timbers for airplane construction, and also in the proper seasoning of such timbers. A good deal of research was also done on timber distillation to produce acetone for cordite manufacture. Several factories were erected and worked to produce this essential material Following on this experimentation, many English firms have erected seasoning kilns of a modern type, and so provided for a more efficient utilization of timber in the United Kingdom. The need for a central laboratory is clearly indicated by the fact that several Government laboratories were engaged in testing timbers, and each had its own method of testing. The result is that the data from one laboratory are not comparable with those from the others, and much of the work done thus loses its value The same conditions apply to such timber testing as has been done in Australia, and one of the first tasks of a Forest Products Laboratory in this country would be to standardize all such work, and thus obtain data that will be of the greatest value to our timber export trade. Plenty of evidence is obtainable to show the harm done to the reputation of our timbers, due to a lack of such information.

In Norway, in spite of its large forest areas, nothing has been done in the direction of research with the idea of preventing waste, and probably that country will be faced with a grave situation in regard to its forests before this is done. It is a pity that it usually needs such a crisis to sufficiently awaken public feeling to a sense of what is proper.

In France a great deal of work has been done, but it has been very sporadic. The paper school of the University of Grenoble has done a great deal for this particular industry. Incidentally, at this school an investigation into the possible utilization of Australian Eucalypts for paper-making was carried out. Immature trees of *E. Globulus* were used, and it is very

interesting to note that the results obtained were very favourable and the experts there believe that the immature Eucalypts offer a good material for the establishment of a paper industry in Australia.

Turpentine investigations and some timber testing work have also been carried out successfully. The lack of a central laboratory to co-ordinate the work is, however, very marked, such scattered work has its value, but it leaves an enormous field untouched, and moreover necessitates a good deal of unnecessary overlap.

The Government of India long ago recognized the value of forest research, and established at Dehra Dun a splendid Forest Research Institute. The range of work carried out here is greater than that in any other institution of its kind, and includes sylviculture and such branches of forestry. Attached to the Institute are two forestry schools for training forest rangers and provincial forest officers. So valuable has been the results that the Institute is now to be removed from the school, and to devote its whole time to research. The buildings and equipment are to be enlarged and a larger staff engaged. A sum of £500,000 is being spent on this development, and several officers of the Institute have been sent abroad to gain experience of other places, to purchase equipment, and to obtain a staff for the new branches to be developed. The Institute has kept in touch with industries by means of liaison officers, and there is in consequence the closest co-operation. A splendid development has been the establishment of a Forest Utilization Circle at Bareilly under a special Conservator. This Circle takes the results of the laboratory investigations and converts them to factory scale experiments. When these are successfully worked out the results are available for any industry. The turpentine factories have been a huge financial success, and to demonstrate the possibilities on a large scale the Government is now erecting a spacious factory, costing £120,000. Another result has been the establishment of a bobbin-making industry to supply the Calcutta mills. Much research by the Institute preceded the development of this industry, which is now assured of success.

Timber preservation has occupied a large amount of time at Dehra Dun, and, among other interesting results, the efficacy of the Powellising process for preserving railway sleepers has been thoroughly demonstrated—for a country where the rainfall is not very heavy. This is comforting when one considers the large number of Powellised Karri sleepers in the Trans-Continental railways. Another activity of the laboratory is the employment of a special tanning chemist in making a complete survey of the tanning resources of India. Immense benefit has followed the work of this officer.

Perhaps the most striking practical result of the laboratory investigations is the erection of four large paper mills to manufacture paper from bamboos. The preliminary experiments occupied several years and much work had to be done in removing prejudices. This great success is due to the work of Mr. Raitt, the paper expert of the laboratory.

The field of research into forest products has by no means been exhausted, and if Australia means to utilize to the best advantage such forests as remain to her, and to establish the large number of secondary industries depending upon the forests for raw materials, such research must be begun at once. Results cannot be obtained in weeks or months. In some cases years are needed. Already the waste of wealth through inefficient methods, or through lack of knowledge of possibilities, has been immense. The establishment of a properly equipped and staffed Forest Products Laboratory can do much to prevent this waste. No other method can prove as satisfactory as the co-ordination of all such research under one institution, and it is to be hoped that the establishment of this will be gone on with as soon as possible.—[*Science and Industry*, Vol. 2, No. 2, 1920.]

LUMBERING AND WOOD-WORKING INDUSTRIES IN THE UNITED STATES AND CANADA, VOLUMES I TO III.

BY F. A. LEETE, I.F.S.

(Government Monotype Press, Simla, 1919)

No longer will the Indian Forest Officer, desirous of studying questions of lumbering and of wood-working industries, be handicapped by the lack of a comprehensive treatise dealing with these subjects. This he owes primarily to the industry of Mr. Leete of the I. F. S., who was recently deputed by the Government of India to study lumbering practice in America and Canada Mr Leete travelled many thousands of miles, viewed industries and plant by the score and must have studied pamphlets, catalogues and books by the hundred to get the materials for his work now being reviewed. The author has certainly earned the thanks of his brother officers, to say nothing of the much more extensive ranks of Indian industrial workers, for his comprehensive exposition of lumbering practice and of wood-working industries. Realizing at the very outset the very wide field covered by his undertaking the author very wisely divided the subject-matter into three volumes, Volume I—Lumbering, Volum II—Saw-mills, Volume III Wood-working industries and miscellaneous items of interest to India.

By lumbering in America and Canada is understood all the manipulative operations from felling a tree to getting its timber to the site of the saw-mill or factory utilizing the timber in the rough and naturally logging and transport are the principal items concerned. The author has confined the text to notes and has relied more, as a means of conveying his meaning, on profuse illustrations and excellent bibliographical references both in the text and as short appendices to the various chapters, while in places specially technical points are explained by quotations from standard works. Full information regarding makers of machinery and plant is also given.

There is much to be said for this method of exposition as it enables particular lines of study to be followed up with ease by a

reference to standard text-books, whereas had the author attempted to make his treatise a text-book, the three volumes would have expanded to a dozen and would then have risked being out of date in many particulars soon after publication, so quickly is literature of this nature, mainly American, now being published.

Mr. Leete's work can best be viewed as an excellent introduction to a mass of technical subjects in which expert knowledge or long and specialized study are essential before any application of such information is possible or desirable. This is borne out by the growing policy of the Indian Forest Service exemplified in the creation of a forest engineering service and in the appointment of various specialists to carry on timber preservation and timber seasoning research at the Forest Research Institute and College, Dehra Dun, to give two instances only. The day when the Indian Forest Officer was supposed to be a jack of all trades is fast waning and the specialist is coming into his own. Of the gain to the Department by this change there can be no doubt.

With regard to the general forest officer and the timber contractor Volume I will be the most studied and referred to, while the application of American practice to Indian conditions will involve field work of the highest interest. Whether entire success will result is another question, but that much can be applied is quite certain.

The omission of an account of "aerial ropeways" apart from "skidding" proper will be a matter of regret to Forest Officers in the N.-W. Himalayas, where this method of transport is gradually being developed. More too could have been said about the floating and "driving" of logs in conditions akin to those prevailing in Himalayan rivers. But the author no doubt was seriously handicapped by considerations of space and had to use his own judgment of what was important and what less important. It is also open to doubt if the author has conveyed to his readers the correct use and meaning of "splash dams." Omissions such as the above can be made good by a perusal of an excellent American book on "Logging" by R. C. Bryant, referred to by Mr. Leete.

Volume II deals with saw mills and is an up-to-date description of modern practice and plant. Here again it is not so much the saw as the man behind the saw that matters and it is in this connection as also in prevention of wasteful conversion that Indian saw mills will find difficulty.

Volume III deals with wood-working industries, some of which are already making headway in India such as three-ply wood, slack cooperage and to a smaller extent match manufacture. It is in writing of the last industry that Mr. Leete exposes himself to a charge of "sketchiness." It would have been better to omit his remarks on matches entirely, or alternatively to have expanded them, and made them of practical value. As it is a page or two is wasted which could have been put to better use. Such small defects, however, were probably unavoidable in view of the huge field the author attempted to cover.

The pleasing and outstanding fact remains that those interested in forest enterprises as well as the officers of the Forest Department have cause to be grateful to Mr. Leete for his energy and labour in adding a much needed and most valuable work of reference to India's library of technical works. It has been decided for the convenience of the public to have copies on sale at the office of the Superintendent of Government Printing, Calcutta, at Rs. 3-8-0 per volume, or Rs 10-8-0 per set, postage extra.

A. J. G.

FOREST MANAGEMENT.

BY A. B. RECKNAGEL, B.A., M.F., PROFESSOR OF FOREST MANAGEMENT AND UTILIZATION, CORNELL UNIVERSITY, AND JOHN BENTLEY, JR., B.S., M.F., PROFESSOR OF FOREST ENGINEERING, CORNELL UNIVERSITY.

Published by John Wiley and Sons, New York, and obtainable from Messrs Chapman and Hall, 11, Henrietta Street, Covent Garden, London, at 12*s*. 6*d* net

The first eleven chapters of the book deal with Forest Mensuration in some detail including a chapter on surveying the area. A large part of this contains little that is new to Indian

Foresters, but it brings out the difficulties of having various standards of measurement for timber. We are not faced with the same multiplicity of standard, nor the various log rules that prevail in America, but we have, unfortunately, the trouble of the quarter girth measurement which is a less accurate standard than the cubic foot solid volume measured by the actual mid-basal area of the log multiplied by its length.

It is stated that if the cost of constructing volume tables is to be kept within reasonable limits it is impossible to fell trees for the purpose, but that it is far preferable to measure up trees in a felling area. It is a great pity this is not done in India. Accurate measurements of the outturn of a few thousand trees would help us considerably in many problems and a newly joined recruit could be put on to much less useful work than this.

On page 87 the method of selecting arbitrary sample trees and from them constructing a curve to read off the volume of any sample tree is advocated rather than the more tedious way of selecting a nearly exact calculated sample tree and then using proportions

An interesting method of counting and entering stem analyses is given on page 102 *et seq.* The method of counting is that employed at the Prussian Research Institute, namely, by *even* tens from outside onwards, instead of the more ordinary text-book way of counting by tens from the total age whether it be an even ten, such as 90, or not. The method of booking the results is new to me and seems more logical and convenient than the old method.

Chapters XII, XIII and XIV deal with Forest Organization (the Management of Indian Forestry), Regulation of the Yield and the Working Plan Document. This part of the book is interesting but it is more usefully treated perhaps for Indian Foresters in Professor Recknagel's other book "Forest Working Plans."

Chapter XV deals with Forest Finance and though there is little new to Indian Foresters a paragraph on page 194 showing the financial advantages of a sustained annual yield compared with intermittent working will be of interest.

The last chapter on Forest Administration will be read with great interest and one quotation cannot be resisted. "The District Inspector system is one of *Centralization, e.g.*, all handled from Washington, with long distance correspondence. The inspectors have no authority to correct things on the ground; they merely report usually at great length."

It is but fair to add that the authors are contrasting this system with that of the District Forester system, *i.e.*, one of *Decentralization*, and of which they write with approval.

Enough has been written to show that in the term "Management" American Foresters have come to include far more of the duties of our profession than is comprised in the word as it is employed now in India.

A set of useful tables complete an interesting and notable contribution to forest literature though the book is not perhaps of as much value to us as "Forest Working Plans" is.

With one point I must disagree. In the preface the authors say of the book it "is sufficiently condensed so as to be readily understood by the layman timber owner and manager." It would be interesting to hear what the layman has to say after reading the chapter on "Regulation of the Cut."

S. H. H.

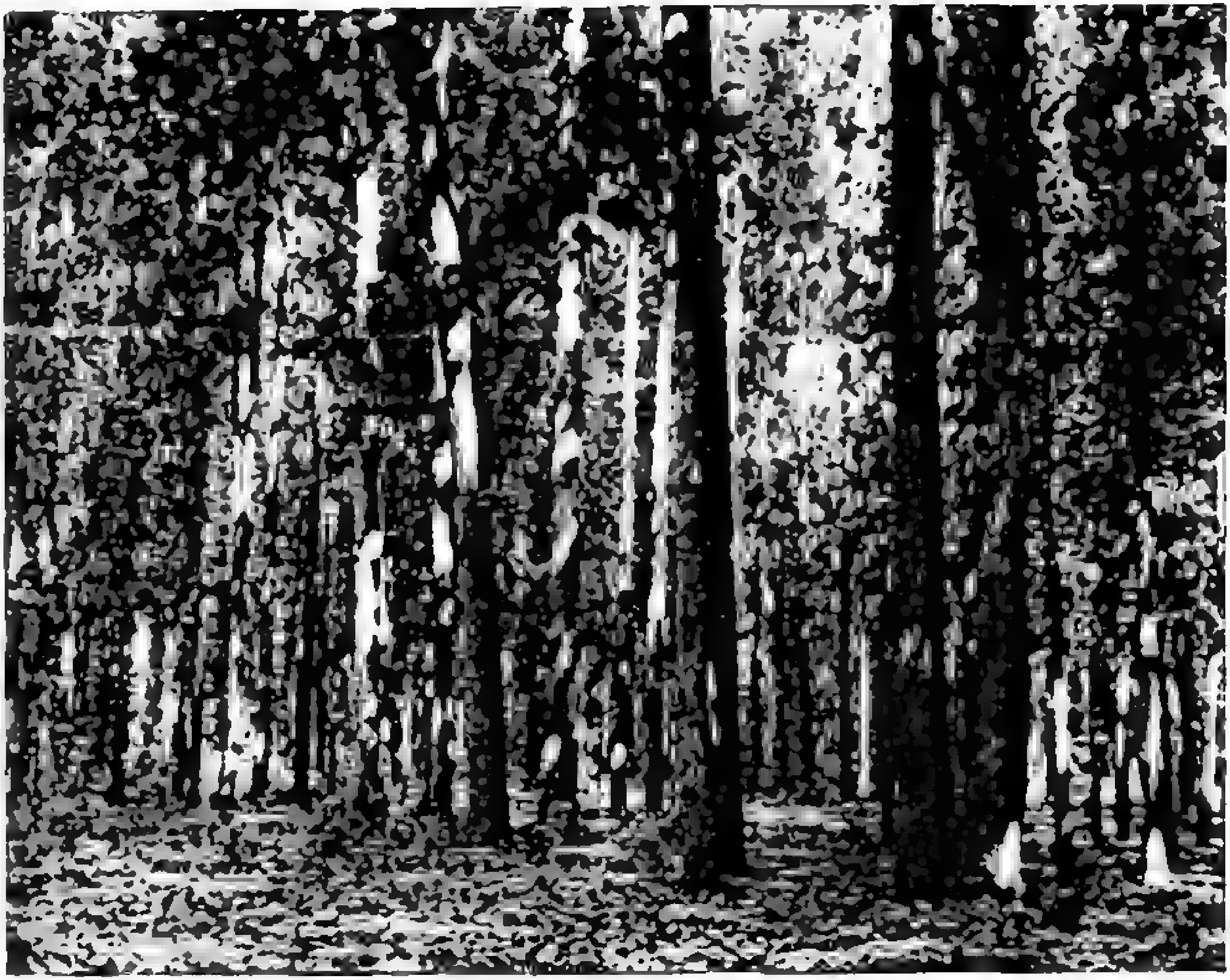

Photo.-Mechl. Dept., Thomason College, Roorkee.

Sal forest of the h[illegible] and Bhabar plateaux.

[illegible]

VOLUME XLVI NUMBER 8

INDIAN FORESTER

AUGUST, 1920.

SILVICULTURAL SYSTEMS FOR SAL.

In the March 1919 number of the *Indian Forester* Mr. Hole outlined a system of regeneration for "the great majority of Sal forests" which consisted essentially of clear-felling in strips on a chess-board pattern and he claimed for this system a saving of 35 years in the regeneration period.

The question of Silvicultural systems for Sal has been very carefully studied in the U. P. for several years past, as the U. P. Sal forests are the great revenue-producing forests of the Province, and the question is for us, therefore, a most important one. Since the publication of Mr. Hole's note every officer who has had anything to do with Sal has carefully examined these new proposals, and considered their application to his forests. It must be admitted that there is an unanimous opinion that these proposals are not applicable to the conditions prevailing in the U. P., and in fact the system of clear-felling in strips has been definitely rejected. It would take too long to discuss in detail all the reasons for this attitude, and Mr. Wood has already dealt with several aspects of the question in the *Indian Forester* but one or two points must be mentioned.

(1) The whole *raison d'être* of the clear-felling in strips system is based on the claim that *established* Sal regeneration will be obtained in 5—8 years. This is a fallacy.

Mr. Hole obtained his results in Dehra Dun by clear-felling in strips *combined with intensive weeding in the rains.* It is generally admitted that this combination will always give magnificent results. The accompanying photograph shows some 3½ year old seedlings which have reached up to 18′ in height, due to careful tending in the rains. But eliminate this tending, and the results are invariably disappointing, a wild growth of grass, *Clerodendron* and miscellaneous coppice monopolizes the clear-felled strip and swamps the Sal seedling growth. Mr. Hole's experiments would have been much more convincing if he had realized from the start that tending in the rains on a large scale is *out of the question* in our Sal forests generally, and had not introduced this vital but impractical factor.

(2) In the U. P. there are three totally distinct types of Sal forest, *i.e.*, (*a*) Hill Sal, (*b*) Plains Sal, (*c*) Bhabar Sal on the old river beaches and flat high level river gravels at the foot of the hills and in the Duns. This third type includes perhaps 10 per cent. of our Sal forests, but *all* Mr. Hole's experiments are located in this exceptional and most favourable type. If Mr. Hole had ever had the opportunity of studying in detail some typical Hill Sal forests, he would have seen that strip fellings on a chess-board pattern were not a feasible proposition and as regards the Plains Sal, in one Range of Ramnagar Division, extensive strip felling experiments (but without rains weeding), have been carried out on a programme drawn up by Mr. Hole, and it is unfortunately to be recorded that they have proved a failure!

The conclusions are, therefore, that Mr. Hole's experiments are not typical, they do not apply at all to 90 per cent. of the U. P. Sal forests, and without rains weeding the system would probably fail in the remaining 10 per cent.

I hope what I have written above will not be misunderstood as an aspersion on Mr. Hole's work. Every Forest Officer in the U. P. and elsewhere who has to deal with Sal is under a permanent debt of gratitude for the invaluable work which Mr. Hole has done on the œcology and seedling development of Sal, which has thrown a flood of light on many of the problems which confront us in the study of this most baffling tree. It is only in the practical application of his results and conclusions that I venture to suggest the man-on-the-spot (who knows local conditions and what is feasible and what is not), might have his say. Before going on to describe the silvicultural systems of working that are gradually being evolved for the U. P. Sal forests a brief note must be given of their past history and management. Protection may be said to have started from 40 to 60 years ago. Previous to that, indiscriminate uncontrolled felling, fires, grazing and hacking took out nearly all the decent crop, and left rubbish. But with the advent of protection, the established regeneration which in most of the Bhabar Sal and the best parts of the Hill Sal was undoubtedly often there waiting its chance sprang up and developed gradually into the splendid pole crops that we now find. For the past 40 or 50 years the fellings have been largely limited to the gradual removal of the inferior rubbish of preconservancy days, and as but a minute fraction of the real increment has been touched these forests have improved beyond all recognition. The Hill forests are far more irregular than the Bhabar forests, but here too the fellings have never approached the real increment, and the crop is often in even-aged groups of small extent.

Up to 1914 all the U. P. Sal forests were treated on the so-called "Selection with Improvement system" except the worst areas where "protection" or "improvement" system were prescribed. Of course none of these (as applied in India) are systems at all in the true silvicultural sense, since they make no attempt at

the production of a normal forest, and ignore such matters as increment and distribution of age classes. Recognizing this fact, a commencement has been made with a real system for the best types of Bhabar Sal forest by introducing the system of Periodic Blocks. To illustrate the method from the Haldwani Division Plan :—There are 6 P. Bs. (of equal area) of 20 years each (rotation—120 years). P. B. 6 contains splendid young pole and sapling crops with a few scattered old mother trees, which have no business to be there, and are being removed as fast as possible. P. B. 1 contains the maturest Sal crop available standing over established reproduction. (By "established reproduction" we understand plants 2′—4′ high, ready to shoot ahead as soon as opportunity arises.) These are to be felled over in 20 years and the reproduction completely freed. Possibility fixed by volume, and *order of visiting* different areas indicated. P. B. 2 contains high pole forest approaching maturity. Here the aim is to induce young seedling reproduction without excessively opening out the crop, so that in 20 years it may be ready to go into P. B. 1. The remaining P. Bs. (3-4-5) are unallotted, and ordinary thinnings and tendings are prescribed. The interesting area is P. B. 2, and our experience tends to show that a good increment felling and removal of suppressed and dominated poles is quite sufficient to start a thick crop of seedlings; their establishment period is certainly slow, but the fact that they will establish themselves under a fairly complete canopy without loss of increment to the main crop definitely excludes these 20 years from being classed as a regeneration period or as forming part of the rotation. The D. F. O. and Marking Officer are given a free hand within these rules, *i.e.*, they may treat P. B. 1 in groups, shelter-wood or clear-felled strips as they deem advisable. The Periodic Block system has been working on a practical scale (about 130,000 acres) for the last 5 or 6 years, and on the whole is giving quite promising results. A certain amount of sacrifice is inevitable, but not to be compared with the sacrifice which would be involved on a chess-board of clear-felled strips. The chief difficulty in allotting areas to the different P. Bs. was that sufficient typical

areas could not be found for P. B. 1 and some areas had to be included which really belonged to P. B. 2

Turning to the Hill Sal forests (which total over half a million acres in all), they are still being worked under the "Selection with Improvement" method (we cannot call it "system.") There is a 15 or 20 year felling cycle, annual coupes are fixed, and all trees silviculturally available in the coupe of the year over the exploitable girth (*i.e.*, 5') are removed. The disadvantages of such a method of work are considerable. It is not a silvicultural system at all, it leads nowhere, no attempt is made to get normal regeneration or a normal distribution of age classes, we have no idea of the real growing stock or increment, and therefore no data for ascertaining how our fellings compare with the increment. The markings tend to degenerate into a hunt for the exploitable trees, and such matters as thinnings, levelling up of even-aged groups, and regeneration, are frequently neglected. We have realised that it is a method which cannot continue indefinitely, and that we must, as soon as possible, introduce something better. But a suitable silvicultural system for these very irregular forests is a difficult problem. They are either of the true "Selection" type, or in even-aged groups of any size from one to a hundred acres. They cannot be worked on a Periodic Block system as it would be impossible to allot areas to any particular Periodic Block, and the sacrifice involved would be unwarrantable. Still less can they be worked on a strip clear-felling system. To meet these difficulties, the following system first proposed by Mr. Clutterbuck, Chief Conservator of Forests, has been gradually evolved, and will shortly be introduced on a fairly large scale:—

(1) *General description of the silvicultural system.*—Silvicultural systems may be classified as Clear-felling, Periodic Blocks, Groups, or true Selection, terms which have a clear and defined meaning to every trained Forester. The system proposed will be any or all of these, *i.e.*, every area will be treated by the silvicultural system best suited to the *crop on the ground.*

(2) *Calculation of the possibility.*—If we know the actual growing stock of a forest, the correct annual yield is given by the formula (Von Mantel's)

$$Y = \frac{\text{real growing stock}}{\frac{1}{2}\text{ rotation}} = \frac{Gr}{\frac{1}{2}n}$$

Gr theoretically includes everything from the largest trees to seedlings, which it is impossible to ascertain, but we *can* ascertain the growing stock of trees over a definite girth (2′ or 2½′ or 3′) and the formula to be utilized, as modified by Mr. Howard, will be

$$Y = \frac{G x'}{\frac{1}{2} n}*$$

Where Gx = the real growing stock of all trees over that girth which is reached in half the rotation (*i.e.*, if the rotation is 120 years, and 3′ is the girth expected at 60 years, then Gx = the stock of all trees over 3′ girth). Now this formula gives us a definite annual yield which approximately represents the real increment of the whole forest. *It includes both intermediate and final yields.* With a periodic revision, it will in time tend to give us automatically a normal growing stock. In all this it is vastly ahead of the old haphazard "Selection with Improvement" method. The system then which is shortly to be introduced in some of the U. P. Sal forests will be a fixed annual yield obtained from the above formula, to be felled as the D. F. O. considers best for the forest, which yield will include *all* trees marked over the girth form which Gx is calclulated. Not a word is said about *prescribing* fixed areas annually for working.

Two preliminary essentials are :—

(1) *A complete enumeration of all trees over a definite girth.*—This sounds rather alarming at first sight, but during two short periods of four months each enumerations of Sal and of miscellaneous species have been carried out over 280,000 acres and for well stocked Sal forest at an approximate cost of 20 per 100 acres or 1 per 1,000 trees. Valuable forests can very easily bear this small expenditure.

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* The calculations involved are too long to quote here *in extenso*, but anyone interested in the matter could probably get them by writing to Mr. Howard at Dehra Dun.

(2) *A carefully prepared stock map and very detailed description of compartments.*—This is essential or every new D. F. O. would be heavily handicapped in carrying out a system where areas are not prescribed. The W. P. O. will prepare this, and will also go so far as to indicate the order in which various areas should be felled over. This indication, together with the description of compartments, stock map, and actual figures of growing stock per compartment will enormously assist the D. F. O. in making the fellings.

The possibility will be prescribed for 10 years.

The areas will then again be enumerated, and a fresh possibility obtained.

(3) *Method of executing the fellings*—The fellings will in practice be of all kinds, Selection Group, Improvement, Thinnings, etc., with a view to create even-aged group patches, or areas in accordance with the *crop already on the ground.*

(4) *Supplementary silvicultural operations.*—A definite proportion of the whole area will be taken up for concentrated cultural works with a view to obtaining complete reproduction of Sal, or other valuable trees more suited to the particular factors of the locality, on land at present producing only weeds and rubbish. In this area no attempt will necessarily be made to obtain an even-aged crop ; where the crop is mature regeneration fellings will be carried out ; where poles exist these will merely be thinned ; but where any area is at present unproductive every effort will be made to induce the reproduction of some valuable species by cutting back shrubs, burning the leaf cover before a seed year, clearings at frequent intervals, and fellings designed to bring on reproduction. If 1/6th of the total area were so treated for 20 years there is little doubt that an

enormous improvement in the quality and value of the growing stock would result.

(5) *Subsequent condition of the crop.*—When fellings of the type described above have passed over a forest two or three times, it will probably be possible to map the age classes with a view to taking more definite steps for their equalization. This, combined with the periodic revision of the yield, and the proviso regulating the attempt to obtain reproduction and complete stocking over a definite proportion of the forest, must in time lead the forest to a state where a system of concentrated regeneration and concentrated fellings will be feasible.

Such an aim is indicated more from a management point of view than from a silvicultural one, as the concentration of the main timber works in definite localities facilitates modern methods of extraction and consequently gives a large increase in revenue.

Some further advantages of this system are :—

(1) Timber for rightholders can be given in any part of the forest area and debited against the possibility.

(2) In the event of damage by insects (*e.g.*, Thano) or by drought (*e.g.*, Haldwani, Kheri, Bahraich) the special fellings necessitated could be debited in the possibility balance-sheet.

(3) The danger from damage by fire, insects or drought would be reduced compared with large areas of uniform age.

I will anticipate three obvious criticisms to the system :—

(1) In a very abnormal forest, the formula breaks down, *e.g.*, if the forest consisted exclusively of 3′—4′ poles, we should have to fell large numbers to obtain the fixed yield, which could involve heavy sacrifice. This is true, but in cases of extreme abnormality every system breaks down, and has to be modified, and in actual practice such extreme abnormality does not arise.

Photo, Mechl Dept., Thomason College Roorkee.

Sal Seedlings $3\frac{1}{2}$ years old, which have never died back, 18′ maximum height.
Due to weeding in the rains and irrigation.

(2) That no steps are taken to ensure *normal* regeneration. Certainly no direct steps are taken, as in systems based on area, such as Periodic Blocks, or clear-felling. But the matter is by no means left to chance as in the existing haphazard "Selection with Improvement" method, as the following remarks will illustrate. A reference to p. 321 of Schlich's Manual of Forestry, Vol. III, will show that the periodic revision of the yield calculated on Von Mantle's formula does in time tend to give a normal distribution of the age classes. Where we have a deficiency of growing stock and of the older age classes, the formula gives a yield less than the real increment, where an excess, the yield is greater than the increment. In the first case an area less than the normal is under regeneration; in the latter case, the marking officer is *obliged* to fell more heavily in his older woods (either by selection, groups, or shelter-wood), with the object of getting regeneration, or he will not get his possibility. If it is clear then that the system tends to even out irregularities, and ultimately leads to a normal distribution of the age classes, surely it follows that steps *are* being taken to ensure *normal* regeneration?

Moreover the proviso, that over some definite proportion of the whole forest particular attention should be paid to regeneration, does, it is considered, adequately dispose of the criticism that "no steps are taken to obtain *normal* regeneration."

(3) That the system is too complicated for Indian conditions and the establishment available for marking the annual coupes would not be up to it.

Admittedly, the *true* selection or group selection systems with a volume possibility is the most difficult system known to Forestry, and calls for a thoroughly sound knowledge of silviculture, for in every coupe and every

compartment, every sort of silvicultural marking comes into play, and admittedly, the present marking establishment, whose ideas of marking are based on a hunt for 5′ trees and the removal of obvious rubbish, would require educating to an altogether higher plane. But it will be a sorry thing for the Department as a whole (and for India generally), if all future progress is to be baulked by the plea of inadequately trained staff. We have learnt sound silviculture in Europe, are we incapable of handing on that knowledge? I do not believe it. And if (as I have tried to show above) the clear felling or Periodic Block systems are not yet applicable, we have no alternative to this system except a thing which is no system at all.

It is not claimed that this system is the last word in the management of Sal forests, it *is* claimed that it is an enormous improvement on the present haphazard method, it gives full scope for silviculture, in fact it enforces silviculture since (as mentioned above) a definite portion of the yield will be obtained in thinnings and if no demand for poles exists, it is up to our Utilization Officers and Forest Engineers to create a demand. In the U. P. forests at least it will give an enormously increased yield (hitherto, as pointed out above, we have been taking but a fraction of the increment), and a justified increase; it will necessitate very intensive working and a sub-division of divisional charges, which by all European standards are at present usually preposterous; it will give an immediate and justified jump in revenue, and as the forests continue to fill up (as they will) and the increment continues to increase (as it will), the yield and revenue will continue to increase proportionately. Incidentally we get the enormously useful information of what our actual growing stock or Forest Capital is, and the periodic revisions give us our actual increment, and definitely prevent overfelling. Given improved and increased staff, improved methods of transport if necessary, and improved markets for all the produce, the system is entirely practical.

In conclusion I must add that the object of this note has been (1) to explain why we have not been able to adopt Mr. Hole's suggested system of management for U. P. Sal forests, (2) to indicate what alternative systems of management we are gradually coming to, (3) to *invite* criticisms on these systems from any readers of the *Indian Forester* who are sufficiently interested in the subject.

E. A. SMYTHIES,
Silviculturist.

FORESTRY WITH THE B. E. F.

BY J. D. MAITLAND-KIRWAN, I.F.S.

(Continued.)

As the F. D. C. O. of Crecy Forest was on leave in England in March 1918 I went to Rouen in his place to be present at the monthly meeting of F. D. C. O.'s who, as I have explained in a previous article, met every month at the office of the Deputy Director of Forestry to settle the programme of work in the L. of C. forests for the ensuing month. While there we heard of the launching of the great offensive by the Germans on the 21st of March, and that offensive was destined entirely to upset the programmes we had so carefully made out. We hurried back to our respective forests and there awaited developments which were not long in coming. One evening an officer on Lord Lovat's staff arrived with the information that the need for pickets was urgent, and asked how many we could supply daily. We were, I think, despatching somewhere about 5,000 a day by rail, which he said was not nearly sufficient, and he told me that in future I must send away at least 30,000 a day and be prepared to send up to 60,000. He further informed me that as there was a serious congestion on the Railways he was sending me an officer in charge of 45 lorries (making 60 altogether with those we already had) who would arrange to take the pickets by road to the points where they were needed.

The problem was a serious one as we had practically no reserve stock of pickets in hand, and I saw that the first thing

to be done was to close down all other work. Under instructions from Rouen, therefore, the work at the saw-mill was suspended and the Canadians who formed the mill personnel were sent into the forest to cut pickets. The Canadians played up splendidly, and a party of them under the Sergeant-Major used to turn out after their work for the day was over and cut pickets until it was quite dark. I was told that after the rush was over it took another party a considerable time to clear up the havoc which the Sergeant-Major had wrought among the coppice stools. Arrangements were made with the O. C.'s of the Chinese Labour Companies to explain the urgency of the situation to the coolies, and to try and enlist their good-will, for it was feared that if they were only on ordinary task work the number of pickets required would not be obtained. The Chinese seemed quite to enter into the spirit of the thing and worked with a will, but of course just when all the labour was most needed we were told that the Chinese were to be removed and replaced, eventually, by two companies of German prisoners. The policy at the time was to send all prisoners back to areas further behind the line as the Germans advanced, and to replace them by Chinese, and although the policy was no doubt sound it was very awkward for Crecy at that particular juncture, for it not only meant carrying on with half the labour (supposing that only one Company was moved at a time), but it also involved diverting a certain amount of labour to carry out the necessary alterations in the Chinese camps so as to get them ready for the German. In spite of protests, however, one Chinese Company was immediately withdrawn, and during the height of the picket rush we were left with only one Company. Luckily they left the best Company but I had great difficulty in getting them to do so. This Company, in addition to being the better of the two at their work, was camped in that part of the forest where most of the coupes containing wood suitable for pickets were situated and I, therefore, stipulated that this Company should be left for a time, and to this the Labour Authorities agreed. However, a day or so before they were to go a telephone message came to say that it had been decided to withdraw that Company, and leave me the other ; so I at once rang up

the Director of Forestry and told him that if this intention was proceeded with it would be impossible to supply anything like the number of pickets required. Lord Lovat, on hearing this, immediately communicated with the Labour Directorate, and I was allowed to keep the Company I wished. It was unfortunate that just at that time the O.C of that Company, who represented most of the driving force, was on leave, but his subalterns worked with a will and did wonders

The French were, of course, particular that we should fell the coupes in an orderly manner, starting either from one end or from both, and cutting everything as we went, and usually the work was carried out in this way It was soon apparent, however, that if we continued this method we should never get the number of pickets required, and I, therefore, gave orders that only those coppice stems which were likely to provide pickets of the proper specification should be cut. It was also evident that more coupes would be required immediately, and the French Liaison Officer was sent down from Headquarters to arrange about this. As soon as he arrived at Crecy his subordinates poured into his ears tales of how the Chinese were hacking the forest to bits and were neglecting to fell all stems except those of such a size as would give them pickets. He was furious at this, and still more so when I told him that it was under my orders that they were cutting only picket wood, and that they had been doing so for several days I can almost hear him now exclaiming over and over again "Si je l'avais su, si je l'avais su (if I had only known)," and he stated that under these conditions no more coupes could be allotted, and announced his attention of going to Headquarters and reporting the matter to Lord Lovat at once. A promise that the coupes would, of course, be properly cleared up as soon as the rush was over scarcely mollified him at all, and off he went. I at once got busy on the telephone, and what sort of reception he got when he reached Headquarters I do not know, but at any rate we got our coupes all right, some 50 of them, and the work was allowed to proceed in the manner directed. A French Forest Officer was, however, sent down to keep an eye on the work and was stationed

in Crecy Forest until the picket rush was over. He made my life rather a burden with his daily, but by no means groundless, complaints, to which I gave all reasonable attention. It was however impossible to carry out the exploitation with the same care as before and at the same time to increase the supply of pickets to such an enormous extent He must have recognized this, but of course he had his own orders to carry out, and with the charm which all French Officers seem to have he performed what must have been an unpleasant duty in the nicest possible way.

The reason why the French were so anxious to keep the coppice fellings under control was that no coppice was allowed to be cut after the growing season had begun, for in that case, as every Forest Officer knows, the resulting coppice shoots are weakly. It was now close on April, and the French thought that we should have no time to go over the areas again, clean up the untrimmed stools, and fell the rest of the coppice before the summer was far advanced, and that, therefore, regeneration over a large area would be affected. The Chinese, who usually did excellent work, had, in their anxiety to cut the maximum number of pickets a day, left many of the stools in a terrible condition, and the French certainly had cause for annoyance. The distant thunder of the guns, however, told us that the Germans were even then knocking at the gates of Amiens, and it seemed quite on the cards that we might have to leave Crecy. Some of our Officers thought, therefore, that the French Forest Officers were very unreasonable in their demands, and said that the one thing which would compensate them for a German advance would be that the Germans would probably hack Crecy Forest to bits. The French, however, proved perfectly right in looking ahead and even in a crisis of that kind, looking after the management of their beloved forests, annoying as it was to us at the time, and it is pleasant to be able to state that when the urgent need for pickets was over, and the Germans were thinking of turning their faces once more towards the Fatherland, we were able to clear up all the coupes to the entire satisfaction of the French, and I have no doubt that they are now full of young coppice shoots.

About two days after we had received the order about increasing the supply of pickets the Transport Officer arrived with his 45 lorries. He stayed until the rush was over, and we used to meet about 10 P.M. every night to discuss the next day's programme and to decide on the number of lorries required at various points the following morning. The transport was a great difficulty at this period. We were in time able to cut a sufficient number of pickets, but it soon became clear that the problem was not merely to cut them but to get them to the road-side ready for the lorries. All the available Decauville rail was put down, and by working the Chinese in shifts the trucks were kept going from dawn to well after dark Every available horse was pressed into service, and in many cases they worked until they dropped from sheer fatigue. At this time the coupes were very muddy, and pulling heavy waggons full of pickets was terribly hard work for the horses. It was necessary to ascertain each evening how many pickets had been brought out of and how many remained inside each coupe, and how many were at the various loading points ready for the lorries. Next morning they had to be counted into the lorries, for of course an accurate record of the numbers sent away had to be kept, and the mere counting of these was no light task. However it was accomplished somehow or other and the lorries were sent off to destinations of which Headquarters had notified us by telephone the previous evening. Most of them went to a big dump at a place called Frevent and were, I believe, required for wiring a new defence line which was then being dug. I went to Frevent with the convoy of lorries one day, and I never saw such a sight as the place was, nothing but pickets as far as the eye could reach The Officer in charge was tearing his hair and begged me to stop sending them for a day or two as he had nowhere to put them, and the roads near the dump were so cut up by the constant traffic that it was difficult to keep them in sufficiently good repair to enable the lorries to approach and discharge their loads. We were, however being spurred on by Headquarters to greater efforts, and as they seemed to think that the fate of the war would be

decided by the last thousand pickets I could give this much worried Officer little hope of any relief. I suppose that these pickets were all eventually used, but we did hear stories of Officers who said they could not understand why the Forestry people insisted on sharpening one end of their firewood! The first day the lorries left Crecy they took a load of over 29,000 pickets, and this load was increased daily until it reached nearly 40,000, after which the need gradually died down. When the returns for the various forests came out we were pleased to find that Crecy had sent away more pickets during the critical period than any other L. of C. forest.

Picket making, however, was not the only change which the German offensive brought us. With the enemy commanding the railway line in the neighbourhood of Amiens, Abbeville, which was close to Crecy, became a very important railway centre, and numbers of troops passed through the town. The consequence was that the Germans were continually bombing it and the place became very dangerous at night. We used to hear the German planes coming over regularly about 11 P.M. and the raids would last for half an hour or so, and would sometimes be continued at intervals throughout the night. We were in comparative safety at Crecy, as although the forest was a very distinct land-mark, and as such seemed to form a sort of rallying point for the planes, yet bombs were not dropped on it except by accident. Many people were, however, killed in Abbeville, and there was a general exodus from the town every night.

Among those who lost their lives there were a number of members of the Women's Army Auxiliary Corps, or "W.A.A.Cs." as they were always called. There were a number of them in Abbeville, and when the raids began they used to take refuge in trenches which had been dug for the purpose in the camp in which they were quartered. One night, however, a bomb was dropped straight into one of the trenches killing eight or nine of them outright. Arrangements were then made for all the W.A.A.Cs. in Abbeville to camp in Crecy forest each night, and we were ordered to prepare a camp for them, which of course we

were very glad to do. Every evening three or four hundred W.A.A.Cs. used to arrive in lorries, sleep the night, and depart about 6 o'clock the following morning. As may be imagined Crecy forest soon became a rallying point for all the troops in the country-side, and the W.A.A.C. Officers used to allow their charges to promenade with their men friends until a certain hour when the Canadian Sergeant-Major used to go round and clear the camp. For weeks the W.A.A.Cs. came out like this every evening, and their advent furnished a pleasing interlude in the monotony of our lives, and I doubt not in their's also.

We also prepared a camp for the Y.M.C.A. ladies, who used to come out by car every night, and it was a pleasure to feel that we could do anything for our country women at a time like that. Among the Y.M.C.A. contingent was a concert party who gave us one or two excellent shows, which were very much appreciated.

The bombing went on for a considerable time and great damage was done in Abbeville. One day one of our Labour Officers met Sir Douglas Haig driving with one of his Staff Officers in the neighbourhood of the forest; Sir Douglas stopped the car and questioned him as to the damage done in the vicinity, and said that people must not be alarmed at the raids, and that in all probability they would get worse for a time. The other Officer expressed the opinion that they were the last kick of a dying dog, and so indeed they proved to be.

Changes occurred in the village of Crecy as well as in the forest. *After the Fifth Army had made its memorable retreat* its Staff made Crecy their Headquarters, and the Army was termed no longer the Fifth Army but the Reserve Army. We did not welcome with any great enthusiasm the influx of shoals of Staff Officers, and when my major was ejected by one of the Generals from the comfortable billet which he had occupied for some months I had an opportunity of learning a variety of Canadian expressions with which I had hitherto been happily unacquainted. We shortly afterwards moved up to the forest camp, however, and left Crecy to the Staff, for it was no longer a fit place for any Officer without red round his hat. One advantage

the Reserve Army did bring us, and that was a splendid concert party run by Leslie Henson, the well-known actor who was Entertainments Officer to that Army. A better show than he put on I have rarely seen, and it was the greatest treat to Officers and men alike.

As the urgent demand for pickets died down the work in Crecy gradually began to resume its normal character. We had been transforming both Chinese camps into German Prisoner camps (for the Authorities were very particular that P. O. W. camps should conform to the pattern adopted, especially in the matter of wiring), and one Company had arrived during the height of the picket rush. They were not altogether welcome as it meant all the bother of training them for the work; they had, however, for a wonder done forest work before and soon tumbled to the special conditions in Crecy. Our other Chinese Company was also moved soon afterwards and replaced by Germans. They were as sorry to go as we were to lose them, and the O. C. told me that he did not expect to get such good work out of them again. They had taken the greatest pains to learn the forest work, had done their very utmost during the picket rush, and had taken especial pride in getting their camp into first class order. Having done all this they were being pushed out to make room for Germans in order to be put on work of an entirely different nature, and they naturally felt that the Authorities had not treated them quite fairly. Now that the danger of a break through by the enemy had been averted there was no apparent reason why they should not have stayed, but the wiseacres of the Labour Directorate seemed more concerned to educate the Chinamen in as many branches of work as possible than to keep him at a job at which he had become really proficient.

It is not my intention to say anything about German labour at Crecy, as I have already dealt with the subject generally in a previous article. Within a period of about four months our white labour had been replaced by Chinese, and the Chinese in turn by German, so that the forest now resounded with harsh

guttural shouts instead of with the cheery cries of "Chow-chow." These constant changes were almost enough to break the hearts of those who had to train the labour, and one would have thought that a period of rest was now due. Not so, however. It was decided to transfer Crecy forest from the L. of C. Group to the Armies Group, and Major Hellmuth's Company to the Canadian Forestry Corps and all this involved administrative changes. The Company now became No. 1 Canadian Forestry Company, but some new Officers were sent to it, and a number of N.-C. Os. and men as well, the result being that the men of the old Company felt that they were losing their identity, for they were always proud of having been the first Canadians to do forestry work in France and for this reason the new Officers and men were not particularly welcome, although of course there was no personal feeling in the matter. Major Hellmuth remained on as O. C. of the Company for a time, but was shortly afterwards appointed as F. D. C. O. of the Forêt de Roumare in the L. of C. Group, while I was temporarily transferred to the Armies Group, and ordered to work not under the Company but under one of the Officers on the Headquarters Staff of that Group. As was I think customary in the Canadian Forestry Corps the Canadians themselves did the actual felling and this required very careful watching. The felling was done by the new men who had just been attached to the Company, and who therefore knew nothing about the local condition. Now there is no better axeman in the world than the Canadian, but his ideas as to how high stumps should be left and of the manner in which the coupes should be cleared up were sometimes rather primitive. The Officer on the Staff of the Armies Group whose business it was to look after the exploitation was therefore rather nervous as to what would be the result of the Canadians' onslaught on a forest in which the French took such particular pride, and he was anxious for some one who had a knowledge of the local conditions to remain and supervise the work on his behalf. As I was messing with the Company whose work I had constantly to criticize, and as I was moreover the junior officer in the mess (for the most

junior Canadian Officer always has two pips), the position was rather awkward, and I soon availed myself of Colonel Oldham's offer to give me a post in an L. of C. forest. I was however very sorry to say good-bye to Crecy. Through the untiring efforts of Major Hellmuth's Company the forest was now in an excellent condition for securing a maximum monthly outturn. The coupes were all in good trim, so that there was no longer any necessity for diverting any labour to the unprofitable work of cleaning up. the charcoal work with all its attendant worries was over for the year; large numbers of logs were on road-side ready for transport to the mill; the railway through the forest was practically completed, and a new saw-mill, for which we had been pressing all the winter, was in course of erection. The various forest camps, too, had been built and were in excellent order, and the labour companies were properly trained to the work. All the Canadians had to do then was to step in, complete the construction of the saw-mill, and send away material as fast as they could turn it out.

I was very glad at any rate to have been able to remain at Crecy through the spring, for the beauty of that season was an ample compensation for the misery of the winter with its rain and snow, its mud and bitter cold winds. There was nothing very beautiful about the forest in the winter; so cold and grey and bleak was it that we should probably have thought it ugly if we had had time to consider the matter at all. But the miracle of spring changed all that, and as with a magician's wand transformed the compartment lines into veritable fairy glades, and painted the sombre grey of the coupes with a delicious colour scheme of the most delicate shades of green. Kipling somewhere pictures the Forest Officer as watching the "green mist" of his plantations rising from the ground, and no phrase could more tellingly describe the advent of spring in a young beech forest. Almost imperceptibly the prevailing tone of grey took on a tinge of misty green, and before the beech realized what was happening the hornbeam burst into leaf. The beech followed, and later on the oak, and as one looked through the

green tracery of the overhanging branches to the brilliant blue sky beyond, for "Sunny France" was living up to her name, or glanced along the rides carpeted with young grass and flecked with splashes of yellow where the primroses were coming into bloom, the whole forest seemed like some fairy land. The distant roar of the guns, telling of death and destruction, seemed sadly out of place in such a scene, and one felt that real Peace on Earth could only come through the healing power of the same Hand at Whose touch the sleeping forest had been recalled to life.

Before finally leaving Crecy I managed to get 14 days' leave, and if the Hand of God was manifest in the forest the hand of man was strikingly apparent in the leave train arrangements. Those who were lucky managed to get a car to Boulogne and those who were not had to endure a journey by troop train, the misery of which in winter was appalling. The carriages usually had the glass of at least one window broken, and only too often all the windows were missing. Sometimes the doors had been wrenched off, and the cushions, if there ever had been any, were as a rule conspicuous by their absence. The carriages were unwarmed, there were no lights of any kind, and of course no arrangements for food on the journey, and the trains went so slowly that the passengers were almost driven mad. All this was perhaps inevitable on account of the shortage of rolling-stock and the movement of troops, but what did not seem so inevitable was the interminable time that Officers and men were kept waiting about at stations, the Authorities not seeming to know, or for the matter of that to care, when the trains would start. I will give one instance of this only. On my return to France after my second period of leave I reported myself to the R. T. O. at Boulogne, and asked what time the train would leave for Rouen. I was rather annoyed to find that there was not one for 24 hours, as I could easily have caught it by coming by the following day's boat and thus secured an extra day at home. However I determined to enjoy myself as well as I could in Boulogne, and I reported myself again at 11 A.M.

next day in time to secure a corner seat in a carriage, which, although it lacked glass and cushions, was otherwise very comfortable. I noticed that the troops who were waiting about were not getting into the train, so I made further enquiries and was told that although the train would eventually go to Rouen it had to go to Calais and back first! All of us who had taken our seats had, therefore, to get out again, and the wretched troops were marched back through torrents of rain to the Rest Camp. I was ordered to report again at 3 P.M., which I did, but found of course that the train had not returned from Calais, and was told to come again at 5 o'clock. At that hour I turned up again and was informed that although the train had not actually arrived it was expected every minute, and that I had better not leave the platform. The troops had had another wet march from the Rest Camp, and thousands of us waited about on the platform until the train actually did arrive, just 3½ hours later. It was then found that there was not room in it for nearly all the men, hundreds of whom had to be left behind on the platform and were, I suppose, marched back once more to the "Rest Camp," of which they must have begun to loathe the sight. We landed at Rouen next day after a horrible night, feeling more dead than alive. We were however much more fortunate than many others. A few days afterwards an Officer who had just come back from leave by the same route told me that the Officers were herded together in a cattle truck, and that when the train reached Abbeville next morning one of them, who by some miracle had managed to fall asleep in spite of the cold, was found to be frozen stiff and had to be taken off the train and sent to hospital. It is no wonder that there was constant grumbling at the way the leave trains were managed.

On return from leave I was sent to Forêt D'Eu with Headquarters at Blangy, a small town a few miles south of Le Treport. I was only there for a month while another Officer was on leave, and as the work followed much the same lines as already described I will not refer to it in detail. Forêt D'Eu was a very large beech forest and was divided into the Haute and Basse Forêts, both

being under the same F. D. C. O. Labour was provided both by P. O. W. and Chinese, and a certain amount of civilian labour was employed as well. There were several saw-mills and the forest was fairly well served by railways. Forêt D'Eu was a State Forest, but it had previously been the property of the Duke of Orleans, from whom it had only recently been purchased. A great portion of it had apparently been worked as Coppice-with-Standards, but this was now being converted into High Forest. The coppice had evidently been well thinned, but there were still a number of very big standards remaining, and a large number of our coupes were in forest of this class. These so-called "Coupe d'Extraction" were very difficult to work with doing considerable damage to what had formerly been the coppice, but was now really pole forest. The French guards used to mark these trees with an arrow indicating the direction in which they wished them thrown, but their optimism was not always justified by the results. A good deal of damage was unavoidably done, but I fancy that our fellings in these coupes must really have been welcomed by the French, for considerable benefit must have resulted to the underwood by the removal of an enormous number of these old standards.

An unusual feature in Blangy was a Y. M. C. A. hut in the Forest camp, and this was a perfect God-send to the men. It was run by a Scottish lady, sometimes quite alone and sometimes with the help of one of the Y. M. C. A. men workers, and besides spending hours daily attending to their bodily needs she organized concerts and other entertainments for them on week days and Gospel services on Sundays, and thus helped in a great measure to lighten what for them must have been a desperately dull time. There was plenty of sympathy for men in the front line, but those in the back areas, and especially in places like Blangy remote from any large town, also had their trials. True they were in no immediate danger, but that very fact robbed their lives of all excitement, and the constant toil day after day, from dawn to dark, in all weathers, with very little chance of recreation, and with no chance at all of distinguishing themselves, made up

a somewhat drab existence. For that very reason this lady, although she received offers of employment in important centres where her services would very likely have brought her a decoration, unselfishly decided to stay on at Blangy, and the work she did was deserving of the deepest gratitude on the part of Officers and men alike.

At the beginning of August I was transferred to the Forêt de Roumare as A. F. D. C. O., the same forest to which Major Hellmuth had already been posted as F. D. C. O. This forest, about which I shall have something to say in my concluding article, had only recently been handed over to us for exploitation, and as there were at that time no Labour Companies in it there was not a great deal to do. Colonel Oldham, therefore, asked me to write a note on Forestry for circulation among the Officers and men working on the L. of C. forests, and this I did, but as it was not published until after the Armistice it cannot have been of much use. The object of the note was threefold—to give the men some idea of the rudiments of Forestry with the idea of giving them more interest in their work and in the forests generally, to show how certain operations should be carried out, and finally to explain the French point of view. I have already hinted that the men sometimes did not take quite kindly to the restrictions imposed by the French Forest Officers, and this was only natural seeing that they were quite ignorant of the reasons which made them necessary. An incident occurred in one forest which, so I was told, particularly excited the wrath of the Labour people. Time and again it had been impressed on them that they must take the greatest care of regeneration and that it was a terrible crime to injure a single seedling unnecessarily, when, lo and behold, one fine day some Frenchmen came and cut a lot of it down! The reason of this of course was that in that particular forest the Shelter-wood Compartment System was in force, and under the provisions of the working plan the advance growth had to be cut down in order to secure as uniform a crop as possible, but naturally the ordinary man could not be expected to understand this unless it was explained to him.

Another thing which irritated officers of even the highest rank was that the French "always gave us the worst trees and kept the best for themselves," and so, as they praised it, "tried to put one over us." Without some knowledge of the elements of Forestry they could not of course appreciate the fact that in marking thinnings and seedling fellings (for a large number of our coupes were in forest of this class) the worst trees are as far as possible marked for felling, the best stems being left for the final crop, and that the French would have marked on exactly the same principle had they been going to do the exploitation themselves. An attempt was made in this note therefore to explain these and similar points, and to show that instead of "trying to put one over us" the French were merely carrying out recognized principles of silviculture.

(To be concluded.)

WASTE IN TIMBER EXPLOITATION FROM THE CONIFEROUS FORESTS OF THE PUNJAB AND KASHMIR.

With the the rising importance of the commercial aspect of Forestry, not one of the least problems facing the Forest Department is the conservation of timber. This is of special interest in connection with the development of the lumber and timber bye-industries in the Punjab, which can only take place when logs and not scantlings are brought down from the coniferous forests of the hills to the rail depôts.

The general practice at present is to convert logs in the forests into scantlings, cubing from 3 C' to 10 C', and to export these for sale. The reasons for this method are :—

(*a*) the difficulties of log extraction; scantlings can be extracted with greater speed, and hence with earlier recovery of outlay Further the short periods granted in forest contracts exercise an adverse influence on more rational methods of exploitation,

(*b*) the absence of sawmills at rail depôts, and hence the impossibility of utilising wastage to the fullest extent. This too may be traced partly to the short contract periods, which necessarily stifle enterprise,

(*c*) the railway demand for sleepers which till now have been converted more easily in the forest than in the plains, and have set a standard for similar forms of conversion, and

(*d*) possibly to a greater extent than is imagined the action of the Forest Department in discouraging any form of exploitation injurious to regeneration. It is not mere coincidence that all timber coming down the Swat, Kabul, and Indus rivers from Trans-Indus Hill States not under forest management arrives in log form.

Whatever the causes may be, it will be clear from the comparative figures below that this method of exploitation is not only wasteful, but produces timber of little value for the lumber industry. These figures have been kindly supplied by the Sawmill Foreman of the North-Western Railway, Carriage and Wagon Department, Lahore, who during the war has had considerable experience in the mill conversion of conifer logs and scantlings supplied by the Indian Munitions Board from the Punjab river depôts.

The inherent defect of scantlings, apart from their short length (*viz.* 9 to 16′), is the fact that for any period up to 12 months between forest and mill conversion they have had four surfaces exposed to the action of air and water. Owing to uneven conversions in forest, damage in transit, and cracking in driage, these surfaces are useless to a depth of ½″ even in the good scantling. Longitudinal splitting owing to shrinkage is also a most frequent and vital defect.

Taking as an example a I class 10′ × 10″ × 5″ scantling = 3·472C′ to be converted into 5/8″ planking, the result in the mill is approximately as follows :—

(*a*) Wastage owing to facing—

2 pieces 10′ × 10″ × ½ = ·694C′

2 pieces 10′ × 4″ × ½ = ·280C′ = ·974C′

(*b*) Saw kerf wastage, *i.e.*, 5 cuts—
for six 5/8" planks,
5 cuts 10' × 9" × 1'8" = ·390C'
Total wastage = 1·364C'

or approximately 40 per cent. of the original scantling. This coincides with the 41 per cent. loss incurred in the conversion of chir sleepers in the Sitapur Sawmills *vide* United Provinces Administration Report of 1917-18. These sleepers were stated to be II class but on the other hand considerable quantities are believed to have been used in meeting the Cawnpore Leather factories' demand for crating, a demand which is in itself not so exacting as that of the lumber market.

It is true that this percentage of waste would decrease slightly if planking of greater depth or even battens, etc., were sawn, but it is clear that a 10" × 5" scant after facing to 9" × 4" does not leave much room for originality in choice of sizes. The same also applies but in slightly less degree to scantlings of larger dimension.

In the case of logs of a similar quality to the scantling taken above, the mill wastage is 25 per cent. Wastage varies naturally with the type of work done. The 25 per cent. figure is based on the assumption that a mill is converting stock size market planking (*viz.*, 6" to 5/8" in depth, and in width up to 12"), in which case the wastage of the second cut is borne by the consumer. Of this 25 per cent. however a part can be recovered for bye-industries and the balance provides the power for driving the mill. Though the recovery of this item is a most important factor in the financial success of the mill, it is here classed as wastage.

The mill wastage therefore is approximately as follows :—

On scantlings ... 40 %
On logs ... 25 %

The balance in favour of the log is, therefore, considerable, but when these figures are applied to the history of the log or scantling from the forests *viâ* the sawmill to the consumer, the balance is more remarkable. Taking as a basis the yield tables of the Revised Kulu Working Plan and the II quality 24" diameter deodar or kail as the average tree for this calculation,

the wastage n the forest from log to scantling is shown to be approximately 50 per cent. The Kulu gross yield is calculated on the volume of the utilizable log, but 20 per cent. allowance should be made for bark, shrinkage and the upper portion of the bole not suitable for lumber but possibly utilizable for other purposes.

The final figures are, therefore, roughly as follows : –

Exploitation of Scantlings

Wastage in forest	= 50 %
Wastage in Mill 40 per cent. on the scantling, therefore on the original volume of the tree...	= 20 %
Recovered for the consumer	= 30 %

Exploitation of Logs—

Wastage in forest	= 20 %
Wastage in mill 25 per cent. on the log, therefore on the original volume of the tree ...	= 20 %
Recovered for the consumer	= 60 %

By log extraction, therefore, and subsequent sawmill conversion of 30 per cent. more timber could be saved for the consumer. The economy in purchasing logs, resulting from their superior quality adaptability, and small wastage, is in fact well recognized by the local market which pays now Rs. 2-8-0 to Rs. 3 per C′ for the good quality Trans-Indus deodar log as against Rs 2 per C′ only for the far more expensively produced Deodar B G Sleeper.

These figures which are based on actual sawmill experience in the relative wastage incurred by scantling and log conversion, and on the yield tables of the revised Kulu Working Plan, may be taken as a fairly safe guide not only for gauging the extent to which the coniferous forests of the North-Western Himalayas are failing under present exploitation methods to meet the world's shortage of timber, but also the amount of capital which might be sunk in improving these methods.

Timber of the type which these forests could produce if exploited on business lines, is still being imported by India. Locally no better proof of the shortage and rising values can be found than in the experimental tendencies of the timber consuming departments of the North-Western Railway. The engineer

department has found that the deodar sleeper supply has failed to meet its requirements and has definitely accepted the assistance of the creosoted fir and chir sleeper. The Carriage and Wagon Department is shirking the enhanced price of the hard woods hitherto thought indispensable, has commenced experimenting with cheaper species, and has even made a large purchase of Kashmir fir and spruce logs. In addition to the normal local demand hitherto restricted by the war still heavier consumption must be anticipated as a result of the prophesied industrial expansion in India, and the extra burden of the Mesopotamia and possibly East Africa demand

The market is in fact sufficiently promising to justify very careful consideration of an early change in exploitation methods. Unfortunately any such change would entail the prior application of expert engineering knowledge generally beyond the capacity of the Forest Department. The problems are roughly as follow :—

(*a*) The extraction of logs first from the forest to the tributary streams and then down these to the main river. On easy ground this can now be done.

(*b*) The improvement of the main river course to facilitate the passage of logs at all times of the year.

(*c*) The construction of permanent booms at mill site or above canal heads, capable of arresting logs even in flood water.

Of these (*a*) is the most important as at present logs can be floated down all the main rivers at certain seasons of the year. This fact however should not detract from the importance of (*b*) and (*c*). The ideal to be aimed at is the utmost limitation of the transit period between forest and mill site; delay means deterioration and hence loss of timber and revenue, especially in the case of fir and spruce logs which develop water rot very rapidly.

As a preliminary step towards the solution of these problems and following the precedent set by other departments, an expert advisory commission might be appointed. To the costs of such a commission Kashmir, Chamba, Bashahr, Jubal, and other Hill States might reasonably be asked to contribute. The interests of

these States are more vitally concerned than those of the Punjab which only possesses Kulu, but as the Punjab comprises the area of consumption the initiative might well be taken by the Punjab.

The result of such a commission, if favourable to log extraction, would be a definite expenditure policy based on expert advice, the advantages of which, if approved by the local Government and the Durbars concerned, would be considerable both from the financial and forest management aspects.

The capital required might not be immediately available, but such as could be spared or even diverted from sanctioned forest works of minor importance could be sunk gradually in the furtherance of the general scheme, and possible waste resulting from individual and ill-directed spurts of energy would be avoided.

With the increasing introduction of modern working plans, the relation of such a policy to forest management would be even more important. The Working Plan Officer can only base his felling and exploitation proposals on the methods now in force. The introduction of log exploitation and the construction of permanent or semi-permanent works involving capital outlay would almost certainly necessitate a modification in the management of that area for the exploitation of which these works are intended. If management and utilization interests are not to clash, the working plan must necessarily have considered both.

This suggested revolution in exploitation methods is not altogether visionary, but, owing to its smaller demand for man-power, will shortly be driven on to the forest owner as a solution of the local labour difficulties.

The sawyer supply in the southern portions of the Punjab hill tract is even now inadequate to meet the increased demand arising from the introduction of fir and spruce working, and the general forest activity initiated by the rising value of timber. In the immediate future the demand for labour to deal with the revised Kulu Working Plan will be increased greatly, while a similar increase is to be expected on the introduction, when staff is available, of modern working plans in the Simla Hill States. The forest owner must, therefore, choose between the continuance

of the handsawyer with the certainty of never realizing the full value of his property, or the introduction of log extraction with the necessity of previous capital outlay.

The forest sawmill, as opposed to the rail-head sawmill is believed to be under consideration. Such mills however while mitigating the labour difficulty are no solution of the wastage problem, and can only be regarded as an interesting, but temporary, measure adopted in the absence of a wider and more business-like scheme aiming at maximum conversion at rail head.

There is every reason to believe that, provided the forest owner can by departmental working ensure a continuous and even supply of logs, utilization at rail-head can be left safely to private enterprise. The war has awakened the Punjab to the possibilities of its lumber assets, and men with the necessary capital and enterprise are not wanting who would seize a fair opening of developing the lumber industry on business lines.

E. A. GRESWELL,
I. F. S.

TEAK PLANTATIONS IN THE MELGHAT DIVISION OF BERAR.

From the year 1868 until 1879 about a thousand acres in the Sipna valley were planted up with teak under the supervision of Mr. Ballantyne Records of the methods of formation and cost were carefully made in the Forest Journal (presumably by Mr. Ballantyne) and now provide us with valuable data for estimating their real value. The plantations were inspected in 1882 by Sir Dietrich Brandis who left records of the mean girth and height of the trees. They were again inspected a few years later by Sir William Schlich who, however, left no statistical record of the rate of growth. In the year 1903 Mr. Bartlett, then Divisional Forest Officer of the Melghat, marked off three acres, each acre of which was treated as a series of four plots: No. 1 not being thinned at all, No. 2 being lightly No. 3 moderately and No. 4

heavily thinned. The girth of each tree in the plot was then taken and recorded, as well as the mean height of the trees in each plot. The volume for each plot was calculated by form factors. Mr. Bartlett has left the following note on record :—" The form factor used is not on record, recalculation of the volume of one plot shows that it was approximately 0·40 and that factor has been used in continuing this table."

The standard used for the intensity of thinnings is defined on page 473 of Mr Fernandez's Manual of Sylviculture

Measurements were continued each year up to May 1908 when the sample plots were abandoned as not being satisfactory on account of the locality being unfavourable to good teak growth. All the plots were lightly thinned again in the year 1909 and one plot was thinned in 1912. Since then the plots have been left to themselves except that a few individual type trees have been measured up. Fortunately the records have been kept and the plots were permanently marked off with deep ditches. They are thus easily traceable and it is thanks to the very thorough way in which Mr. Bartlett did his work that we have his valuable figures and can supplement them with those showing later growth.

During the last four years while Mr. Kenny held charge of the Melghat experiments have been carried out not only in establishing teak plantations in areas at present holding little or no teak but also in fostering natural teak regeneration under what is known as the Canara system. Something had to be done as in some parts of the Melghat, more particularly in the Gugamal reserve, there is a serious lack of regeneration. Whether this state of affairs is due to fire-protection or the lack of grazing to keep the grass down, or to other causes, I will not here discuss

The Canara system has been tried in most ranges and without marked success except in Gugamal Range where the tending of natural regeneration and the forming of teak plantations was under the personal observation of Ranger Dhamdhare and it is to his zeal and interest in this work that we are indebted for the results we have now obtained. At Ghatang in 1919 I personally

supervised the tending of plants under the Canara system and with these exceptions I consider that the failures are due to the carelessness of the staff in not weeding the young plants. In almost every case in which the original cover has been left and not removed from over the young trees (whether planted or natural) the experiment has been a failure. The best result was obtained in Koha plot I-g of Gugamal Range where the mean height of trees planted under shade is ·79 feet after four years' growth compared with a height of 2·5 feet after three years' growth in clear felled areas of the same locality.

The proportion of casualties is equally striking. At Tambia-khera natural seedlings tended under the original shade showed 86 per cent. of casualties and a growth of 6" after four years, compared with no casualties and a height growth of 4·10 feet in the same time but in a less favourable but neighbouring plot which was clear felled.

There seems to be a clear case for removing all shade from the young plants and in the year 1918 an area of fifty acres was clear felled and it was decided that ten acres should be planted up each year. So far the results have been disappointing, possibly due to the bad seasons of rainfall which we have had and also possibly due to the fact that too large an area was clear felled and that our satisfactory results of clear felling were obtained on small areas of less than an acre each. My own opinion is that clear felling in strips is likely to lead to the best results.

The question to be considered is whether the teak plantations are a sound financial proposition, and provided the soil and other conditions are suitable, the statistics carefully preserved by my predecessors show that teak plantations are a very sound investment for the tax-payer.

Let us turn to the plantations made by Mr. Ballantyne and *the figures preserved by Mr. Bartlett and my more recent measurements.* With Mr. Ballantyne's figures of cost worked out at four per cent. interest the attached table shows that in a frost-free locality an unthinned plantation has a soil expectation value of Rs. 220 per acre, a lightly thinned plantation Rs. 370

moderately thinned Rs. 720 and heavily thinned Rs. 600 after fifty years. In a slightly frost affected locality the unthinned plantation shows a dead loss while the thinned plantations show a profit up to Rs. 105 per acre. In a bad frost locality the plantations do not pay.

It is interesting to note that all Mr. Ballantyne's plantations were made in clear felled areas.

The cost of the plantations were in series 1 and 2 Rs. 13 per acre in the first year, Rs. 8 in the second year, Rs. 8 in the third year and Rs. 5 in the fourth year. In series 3, the cost was Rs. 14 per acre in the first year, Rs. 4-8-0 in the second, Rs. 2-2-0 in the third, Re. 0-10-0 in the fourth and Re. 0-10-0 in the fifth year.

If we can form plantations at this cost or less in equally favourable localities as that of series III we can expect as good results if not better. The average cost per acre of our plantations in the last four years has been Rs. 17-2-0 in the first year, Rs. 5 in the second year, Rs. 8 in the third year and Rs. 7 in the fourth year. Given the same growth as in the average of the four plots of series 3 we get a profit of Rs. 280 after fifty years.

Actually it would be more as thinnings would be made to the best advantage of the wood.

The cost of tending natural seedlings is, however, less than half that of artificial regeneration, while existing data of naturally grown even-aged teak go to show that the results will be almost as good as in the plantations (a volume of 1,300 cubic feet per acre after 50 years compared with 1,500 cubic feet per acre in series III and 800 cubic feet per acre in series I).

I think I have made out a case for more extensive artificial re-stocking of teak woods whether in actual planting or in tending natural seedlings.

I have taken four per cent. as the rate of interest for calculating the cost and the value of thinnings. This is higher than is usual but I have not been able to calculate the cost of the maintenance of the permanent staff per acre, *which however is the same whether the areas are planted up or left unproductive.*

Girth measurements are taken over bark as it is necessary to compare girth of felled trees with those of unfelled trees of known or unknown age in sample plots.

It would be interesting to compare the volumes and values of the measured plantations with those of other teak plantations of known age in the Central Provinces.

J. W. BEST,
I.F.S.

Even-aged teak woods in the Melghat.

Age.	Soil expectation value rupees per acre. Plantations. Series I slightly damaged. Plot I not thinned	Plot II lightly thinned.	Plot III moderately thinned	Plot IV heavily thinned	Series II and V damaged by frost	Series III favourable locality, no frost damage. Plot I not thinned	Plot II lightly thinned.	Plot III moderately thinned.	Plot IV heavily thinned.	Volume of timber per acre in cubic feet. Plantations in frost areas.	Plantations in frost free areas.	Naturally regenerated or artificially sown.	Height in feet. Plantations in frost areas.	Plantations in frost free areas.	Naturally regenerated or artificially sown.	Natural trees in uneven-aged woods.
10	−50	−50	−50	−51	The most favourable plot gives a loss of Rs. 84 after fifty years calculating at 4 per cent and a gain of Rs. 10 at 3 per cent. The rest show a loss.	−32	−32	−32	−32	.	.	...	8	12	10	6
15	−60	−60	−60	60		−41	−41	−41	−41	...	.	.	13	19	15	16
20	−70	−70	−70	−70		−50	−50	−50	−50	210	420	.	18	25	20	22
25	−80	−80	80	−80		−40	−20	20	−20	300	590	...	23	31	26	27
30	−72	−20	−20			+10	+220	+240	+235	400	710	540	27	36	31	32
35	−10	+33	+30	−70		+60	+270	+450	+320	500	900	700	31	42	37	37
40	−20	+50	+55	+100		+115	+310	+560	+418	600	1,100	900	36	47	42	42
45	−30	+40	+61	+105		+165	+340	+640	+519	700	1,300	1,100	40	51	46	47
50	−50	+28	+61	+105		+220	+370	+720	+600	800	1,500	1,300	45	56	50	51

FORMULA FOR SELECTION FORESTS

A large area of forest in India is still treated under the "Selection" system The general method on which the possibility was calculated was by number of trees.

There is no need to go into details as everyone knows how it was done but it demanded—

(1) enumerations;

(2) a knowledge of the time taken for trees of one class to pass into the next higher class, *i.e.*, a knowledge of increment

(3) a knowledge of the percentage of survivals in the passage of trees from one class to the next.

There are several slight modifications but the above is the general outline.

2. In other words the system applied demanded as much knowledge as the application of more recognized methods of calculation.

3. The results of it were an extremely complicated set of calculations, the calculated possibility has often turned out to be inaccurate and it made little attempt to attain a normal forest. With a deficiency in the mature and nearly mature age class even if the forest was fully stocked, it gave a result far below the real increment of the forest

4. Presumably the reason no other formula was applied was because of the lack of knowledge of the increment though, as a fact, the number of trees method also necessitates a knowledge of girth increment and practically all recognized formula necessitate a knowledge of this except Von Mantel's formula—

$$i.e., \text{ Yield} = \frac{\text{total growing stock}}{\text{half the years in the rotation.}}$$

The difficulty with Von Mantel's formula was that it necessitated measuring the whole growing stock, which was usually impracticable in India

5. The lack of a suitable formula rather came to a head with Mr. Clutterbuck's recent proposals for the *sal* forests of the United Provinces.

There is no need to go into particulars of those proposals here but the outstanding feature of many of these forests is that it is known there are ample trees below 3 feet girth to replace the trees above 3 feet girth. Therefore if all trees of 3 feet girth and over were enumerated (a perfectly practicable proposition), the volume of all those trees could be removed plus their increment during half the period, in the time which it takes a 3 feet tree to attain maturity.

Again the trouble was to know what that increment would be.

6. The writer, therefore, has given the following simple formula which does not necessitate any knowledge of increment.

Let V = the volume of all trees in the forest of half the rotation age and over. A girth is of course substituted for half the rotation age and all trees of that size and over enumerated.

Let "r" = the rotation

Then yearly yield = $\frac{V}{\frac{3}{4}r}$

7. The proof of the formula is as follows: -

Assume that the annual increment of each age class is "i." This assumption is not strictly accurate but is made under several recognized calculations of the normal growing stock.

Then in a normal forest the following arithmetical series represent the volume of all the separate age gradations of half the rotation age and over when "r" = the rotation.

Just before felling

$(\frac{r}{2}+1)i + \ldots\ldots\ldots\ldots + ri$ .... (*a*)

ri the oldest age gradation is felled.

Just after felling

$\frac{r}{2}i + \ldots\ldots\ldots\ldots + (r-1)\,i$ .... (*b*)

In each of the above expressions there are $\frac{r}{2}$ terms.

The sum of "*a*"

$$= \frac{r}{4}\left\{\left(\frac{r}{4}+1\right)i + ri\right\} = \frac{r}{4}\left\{\frac{ri+2i+2ri}{2}\right\}$$

$$= \frac{r}{4} \times \frac{3ri+2i}{2} = \frac{3r^2i+2ri}{8}$$

The sum of "*b*"

$$= \frac{r}{4}\left\{\frac{ri+(r-1)i}{2}\right\} = \frac{r}{4}\left\{\frac{ri+2ri-2i}{2}\right\}$$

$$= \frac{r}{4} \times \frac{3ri-2i}{2} = \frac{3r^2i-2ri}{8}.$$

9. The normal growing stock is the average of the two

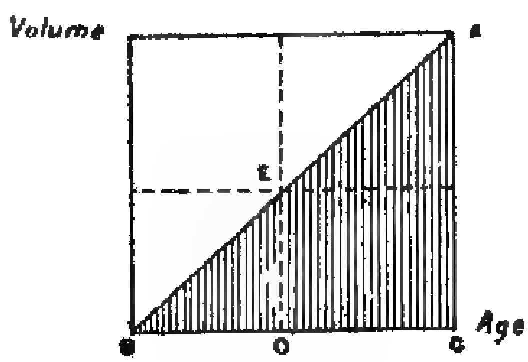
$$\frac{\frac{3r^2i+2ri+3r^2i-2ri}{8}}{2} = \frac{6r^2i}{16} = \frac{3r^2i}{8}.$$

10. A further assumption is now made, also common to many of these formulæ, namely, that the real yield (Y) is to the real volume (V) as the normal yield (ri) is to the normal volume $\frac{3r^2i}{8}$

$$\text{i.e., } Y : V :: ri : \frac{3r^2i}{8}$$

$$\therefore Y = \frac{V + ri}{\frac{3r^2i}{8}} = \frac{V}{\frac{3}{8}r}$$

11. A more simple proof is as follows : Let the Δ ABC = the normal growing stock when the abscissæ and ordinates are age and volume. Let the



total increment yearly of all age gradations be "I," then the normal growing stock will be $\frac{I \times r}{2}$ where "r" is the rotation.

Then the figure ACDE represents the normal growing stock of half the rotation age and over and it is obviously $\frac{3}{4}$ of the $\triangle$ ABC.

But ABC represents $\frac{I \times r}{2}$

$\therefore$ figure ACDE will represent $\frac{3}{4} \times \frac{I \times r}{2}$ that is the normal growing stock of trees of half the rotation age and over.

12. In the above normal forest "I" can be cut yearly and making the same assumption as in para. 10.

$$Y : V :: I : \frac{3}{4} \times \frac{I \times r}{2}$$

$$\therefore Y = \frac{V \times I}{\frac{3}{4} \times \frac{I \times r}{2}} = \frac{V}{\frac{3}{8} r}$$

13. As far as the writer can see the formula, or a slight modification of it, is of universal application.

The only data it requires are—

(1) a decision of a rotation (required under all methods);
(2) enumeration of trees of half rotation age and over (a practical proposition);
(3) the substitution of a girth for half rotation age. As a rule a much better shot can be made at this, when data are meagre, than at the time taken to pass from one age class to another and even if nothing were known and this girth were simply taken as half the girth at the full rotation it would not as a rule give a very wild result, at any rate it would be better than the old number of tree calculations.

It thus requires less data than any other formula and is therefore specially applicable where data are meagre.

14. In applying the formula, or at least in making up a similar one, the first point to decide is the stage down to which enumeration should go.

In the United Provinces it was based on the point below which it was known there were very large numbers of trees, *i.e.*, 3 feet or about half the rotation and hence the above formula.

In other forests it might be 2 feet but it would be equally simple to evolve a formula for that

15. The extreme case would be Bengal where I understand roughly speaking there are no *sal* at al below about 3 feet.

The principle still applies. Obviously as there is no stage at which regeneration begins *all* trees must be enumerated and a formula made up for all the rotation.

It will of course simply give Von Mantel's original formula *but* it will in that case be practicable to apply it because measuring all the growing stock will merely be measuring trees down to 3 feet as nothing below that occurs.

Moreover, if in this case regeneration began to come in at once there would be no hiatus when the present trees were felled.

16. Although this formula will usually give a larger possibility than has been taken before from Indian forests it is a *conservative* estimate compared with the more accurate formulæ.

It automatically corrects either a deficiency or excess of growing stock but takes unduly long to do so in the case of an excess. Revision after a period of years will show this and the possibility can then be increased accordingly.

S. H. HOWARD,
I. F. S.

A NEW SPECIES OF HUGONIA FROM COORG

BY L. J. SEDGWICK, F.L.S, I.C.S

In May 1918 Mr. T. R. Bell, C.I.E., and Messrs A. G. Edie and G. E. Marjoribanks visited Coorg as the guests of Mr. H. Tireman, Deputy Conservator of Forests. A few plants were brought back by Mr. Bell, amongst which was a handsome *Hugonia* in fruit. As it seemed to be something quite new some more specimens in flower were obtained in February 1919 through the kindness of Mr. Tireman. It is evidently a new species, as it is not mentioned in Gamble's Flora of Madras for the preparation of the first part of which (containing *Linaceæ*) Mr. Gamble had the use of all available material collected in South India including Dr. Barber's extensive " South Indian Flora." I give the description.

HUGONIA BELLI, L. J Sedgwick, sp. nova.

Frutex scandens, exceptis gynœcio, andrœcio et sepalorum interiore facie in omni parte sericeo tomento ferrugineo densiter et conspicue vestitus. Folia magna, ramulorum ad 20 × 7 cm, elliptica vel lanceolata, acumine obtuso, marginibus rependo-crenatis; nervi circa 16, obliqui, paralleli, intra marginem arcuati et cum costa venulisque reticulatis in folii utraque facie conspicui. Stipulæ 15 mm longæ, lineares, laciniatæ. Pedunculi inferiores in hamos circinatos conversi; superiores axillares, 15 mm longa, cymata, dichotoma compacta ferentes. Bracteæ ut stipulæ, sed breviores 10 mm longæ. Bracteolæ ut bracteæ sed breviores, 6 mm longæ, sub-laciniatæ vel simpliciter subulatæ pedicillos brevissimos et crassiusculos subtendentes. Sepala 6 × 5 mm, ovata acuta, facie interiore nigra polita. Petala 15 mm, lutea, venosa, contorta, fugacia. Stamina petalis æquantia; filamenta inæqualia, usque ad medium in vagina, cujus basis glandulose incrassata est, cohærentia. Styli 5, filiformia; stigmata sub-bilobata. Drupa (adhuc unica visa est) globosa, fusca, 2 cm lata Endocarpum ligneum, depresso-globosum, longitudinaliter striatum 10-loculare; lusculi loculi semine impleti.

Apud Solepoli in reg. Coorg, ad 120 metr alt. Flores in hiemali tempore.

A handsome species covered with silky ferrugineous tomentum with large crenate leaves, yellow flowers like those of *H. Mystax* but in compact dichotomous cymes with conspicuous laciniate bracts and bracteoles, and similar stipules

A "LEFT AND RIGHT" AT LEOPARD.

While in camp in sal forest in the plains in the third week of May my men brought in news that a leopard had carried away a pariah dog from a village and that they had found about half of if left a little way inside the forest. I decided to sit up, so they went off and made the necessary arrangements.

Getting to the spot I found that it was covered with dense undergrowth and a thick carpet of dry sal leaves. Also there were absolutely no suitable trees for putting up a machan. However they had done their best and the machan was a bare nine feet off the ground resting on a tall white-ant heap and tied to a young sal pole. The machan was a charpoy about four feet by three feet and must have been made for child but luckily it was not infested with the obnoxious insects usually found in such charpoys.

It was half past five o'clock when the men went away and I settled down. In about half an hour a leopard came up and could be seen sneaking through the undergrowth, making absolutely no noise in spite of the thick carpet of dry leaves, which usually render stalking almost an impossibility. The leopard seemed to be very suspicious and took about half an hour to get near to the kill, and then he sat down about five yards away from it and disappeared from view. During the whole of this time he was never clearly seen, only occasional glimpses of him could be caught owing to the dense undergrowth. When the first leopard had got near to the kill and done the disappearing trick, another one began to sneak up behind him. The second one did not get as far as the kill but disappeared some little way off. I sat for some time absolutely motionless but after a bit felt that I must move or die

as the very small charpoy was so uncomfortable that I had got cramp. So I leaned forward slowly to see if the first leopard could be seen near the kill, as I did so he came boldly out on to it. Raising my rifle slowly, a double-barrelled 500 express, I fired and he flattened out on the spot. On the report the second leopard rushed out giving a clear view of his head and neck. Drawing a bead on his neck I pulled the trigger but alas! nothing happened. Looking down I discovered that I had fired my left barrel first and it was the trigger of this barrel that I had pulled again. This commotion made him spot me. Glancing at me for a second he made off going straight away at sixteen annas. However getting on to him again I let off, pulling the right trigger this time. He roared and went well away and I could see and hear the disturbance in the undergrowth a good two hundred yards off.

The elephant and men then came up cautiously. The first leopard was quite dead. We went only a very short way on the track of the second and found a little blood which made it then quite sure that the second one had been hit. However as it would have soon been dark we did not follow up the second one. We set out at 5-30 next morning and soon got on the track. There was much blood and several places where the leaves were pressed down and there were pools of blood showing that the leopard had stopped there for some time. Finally we lost the track near some thorny scrub and in spite of much searching in all directions could not find it again. I then searched around on an elephant but could find no trace of anything. I had warned the men who were with me to keep behind me and near the elephant but they would not and appeared to be absolutely fearless, as most people who live much in the jungles are, of wild animals. After some little time we had got rather separated and I heard a roar and much shouting. Hastening to the spot we found that the leopard had rushed out of a bit of scrub at one man who hit at him with a stout lathi and turned him off. It was in a piece through which I had already been on the elephant. Very luckily he had been severely wounded and no damage had been done.

I searched round and round the place but could not find him. Finally at length I saw the tip of his tail moving and then his head and eyes, in the middle of thick scrub. I had a hasty shot on the wrong side and the elephant moved as I fired and it was a miss. He then ran out slowly into another piece of scrub, again I fired and missed. He then went down into a porcupines' earth and stayed there. I crept up to the edge and peered in but could see nothing. We threw bits of mud in and he growled but would not come out. Finally we put a large heavy log over the hole and covered it over. Then we collected some leaves and brushwood and lighted it just over the hole, but he would not budge. We gave this up and then covered the hole with earth and stamped it down to try to suffocate him but this had no immediate effect, as the hole was twelve feet long as we afterwards found out Then we dug another hole further back to make a small opening to see if he could be got at and shot through that. This proved a failure because we dug it too near the first opening and the leopard was further away underground. Then we made a small hole through the original opening and pushed a long stick in to tickle him up. He had been shut up tight for over half an hour but was not dead because he growled and bit at the stick. Then stick was about ten feet long and the whole of it went in, so we then knew that the hole was a pretty big one. It was then getting very late and very hot so we filled up both holes carefully and pressed the earth down tight and replaced the heavy log. Leaving a man to watch near by we went away.

In the early afternoon some men went out with hoes to dig a trench further back as the stick had shown us the direction and length of the hole. I told them to dig a trench but to be careful not to make any connection with the hole until I got back.

However I set out at 4 o'clock and had not gone two hundred yards, before I met them coming back with the dead leopard, they had dug the trench and got deeper and deeper and still heard no signs so decided to open up a small hole to see. They did this and poked with sticks but still there was no sign, so they increased the hole and soon found him quite dead. "He" was

a leopardess about six feet two inches. Both of my shots in the morning had missed but my shot the night before had hit right in the middle of that part of the anatomy usually presented by a retreating foe

THE RAISING OF EUCALYPTS.

The following information taken from a report of the Forestry Commission, New South Wales, is recommended to all who are engaged in the artificial regeneration of Eucalypts in a dry climate :—

RAISING OF PLANTS IN TUBES.

Plants raised in seed beds are commonly called open rooted plants and are those with which the forester is primarily concerned. Raising plants in pots is too cumbersome and expensive to come into consideration in forestry work, but the adoption of a modification known as the "tube system" is sometimes rendered necessary by climatic conditions and is practised somewhat extensively in South Australia, to which State it was introduced from India.

The necessity for the introduction of this system was due both to the dry summers experienced and to the damage done by spring frosts to frost-tender Eucalypts. If open-rooted plants are to be planted out early enough to catch the late winter rains and thus to establish themselves before the dry summer sets in, the young foliage must of necessity be exposed to the spring frosts to which many species of Eucalypts are particularly susceptible. By growing plants in tubes and transplanting them in the tubes in which they are raised, planting can be delayed until after the danger from spring frosts is past for the earth in the tubes retains sufficient moisture to support the plants without rain for several weeks and casual thunderstorms are sufficient thereafter. No damage is done to the stem of the plant by the tube for this is cut from the common reed—*Arundo donax*—and quickly rots in the ground. The growth of the young plants planted under such conditions is so rapid that at the end of the first growing season the leading shoots are above the level of frost danger.

Small plantations of the reed are maintained for the purpose in swampy ground, and the stems after being cut are sawn by means of a small circular saw into lengths of about four inches, the nodes being, of course, discarded. The tubes are allowed to dry in the sun before being used.

Rectangular beds to receive the tubes are dug out and levelled, the sides being built up with stone or concrete and the bottom covered with a layer of good black soil, well sifted. A rectangular wooden frame about 3 to 4 feet wide with a sliding metal bottom and a removable end is closely filled with tubes, which are generally about 1 inch in diameter and laid on the soil of the bed. Earth is filled in round the edges, the end of the frame removed, the frame pushed up firmly against the end of the bed, the sliding bottom pulled out and the frame then lifted, leaving the tube in position. This is repeated until the bed is completely full of tubes, which are backed up with earth and hammered down with wooden mallets, the level of the surface being maintained by the use of a long spirit level.

After the "*plunging*" of the tubes, as the above operation is termed, finely silted dry soil is laid on and shaken into the tubes by continual knocking with mallets. It is essential that fine and dry soil be used, for coarse or wet soil would clog the openings and result in the tubes being imperfectly filled. After filling, from ¼ inch to ½ inch of soil is swept out of the tubes and the bed watered with a sprinkler until the earth is moistened throughout, this stage being determined by pulling up a few tubes and examining the soil at the bottom.

Seed is then sown at the rate of about two or three seeds per tube and covered with a mulch of sand and wood screenings, the beds being watered several times a day so as to maintain an even state of moisture—neither too wet nor too dry—until germination takes place.

When the seedlings have developed two or three leaves the tubes are taken out one by one, the weak seedlings pulled out, the roots protruding from the bottom cut off and the tubes packed in boxes or tins. This checking of the growth helps to harden the

seedlings and the cutting of the protruding roots stimulates the development of the fibrous roots in the tubes. After being kept in the boxes for about a week the tubes are put out in the lines in new beds with earth partitions between the lines, the tops of the tubes being completely covered with a layer of soil. Similar changes of position are made several times a year, the protruding roots being broken off each time.

In order to provide shelter the beds are surrounded by frames fitted to carry canvas shades, the hardening of the seedlings being obtained by putting on the shades later and taking them off earlier each week, thus gradually accustoming them to more sunshine.

So much detailed hardwork makes the nursery work expensive but much less so than in the case of pot plants. There are compensating advantages, as mentioned above, and also in that economical and successful planting is facilitated, particularly in respect of species deficient in fibrous roots. Also, although the procedure outlined is that adopted for vigorously growing Eucalypts, less handling would be necessary in the case of slower growing conifers if the system were applied to such of them as are difficult to transplant with open roots.

[The advantage of using a section of reed over the usual bamboo basket is obvious. —HON. ED.]

THE EMPIRE TIMBER EXHIBITION.

An item of interest in connection with the introduction of the lesser known Indian timbers to the English market is the announcement that the Great Eastern Railway Company are providing, for the Empire Timber Exhibition, to be held in London in July, one complete first class railway carriage, one third class carriage, as well as a complete composite railway coach 54 feet long, the two former built throughout and decorated with Indian timbers and the latter entirely decorated with Indian timber. The timber required for the above purposes has been presented by the Government of India, which fact will be recorded on a tablet in each of the compartments of the carriages.

REVIEW.

FOREST PRODUCTS: THEIR MANUFACTURE AND USE.

By Nelson Courtlandt Brown, B.A., M.F., Professor of Forest Utilization, the New York State College of Forestry at Syracuse University, Syracuse, New York, Trade Commissioner, United States Lumber Trade Commission to Europe, Department of Commerce, Washington, D. C. Pp. XIX+471.

(New York, John Wiley & Sons, Inc., London, Chapman & Hall, Ltd.) Price 21*s*.

It is wonderful what good illustrations will do to liven up a book. Not that Professor Courtlandt Brown's book wants livening up, for it is typically American in its style, virile and up to date and the only charge of heaviness that can be laid is in a material sense, for it is verily a weighty tome to hold up for any length of time as the reviewer knows to his cost. Why will American publishers weight their authors' arguments by adding a very large proportion of China clay, or whatever it is, to the paper they use?

And with this one and only legitimate "grouse" the one unsatisfactory feature of the book under review is disposed of and the much more pleasurable task remains of drawing attention to the many interesting characteristics of Professor Courtlandt Brown's production; and in any case the "grouse" is "on" the publishers and not the professor.

To epitomize the book is to describe it as a specialized study of forest industries and a wonderfully interesting specialist's study at that. The ground covered is not that usually covered by books on utilization. The author has selected his industries carefully and thereby has been able to make each a clear cut, comprehensive and yet brief exposition, giving statistics of production, concise details of manufacture, essentials for each industry and descriptions of necessary plant, with often a rough estimate of costs, the whole livened up by excellently reproduced photographs, as already mentioned.

The author's war on wasteful methods and wasteful conversion is specially noteworthy, for with rapidly shrinking sources of supply every forester's clear cut duty is to increase scientific production and to reduce waste in utilization. The author explains in his preface that his volume is intended as a "brief treatise preliminary to a more complete and exhaustive work or group of works to be written at some later date."

With this object in view separate chapters are devoted to each of the more important products or group of products and the information summarized under headings in a form readily available for reference. For example, the chapter on Slack Cooperage which contains twenty-five pages is divided into seventeen sections : (1) General, (2) Annual production, (3) Slack Cooperage *versus* other forms of shipping containers, (4) Laws governing the industry, (5) Qualifications for slack cooperage stock, (6) Woods used, (7) Manufacture of slack cooperage stock, (8) Manufacture of staves, (9) Manufacture of headings, (10) Manufacture of hoops, (11) Sawed hoops, (12) Cut hoops, (13) Assembling, (14) Utilization of waste, (15) Equivalents, (16) Stock weights and (17) Grading rules. There are seven illustrations showing a ground plan of a slack cooperage plant, methods of cutting logs, various machines and stages in the processes while the chapter concludes with a short bibliography.

Similar chapters are devoted to Tight Cooperage, Wood Pulp and Paper, Tanning Materials, Veneers, Naval Stores (Rosin, Turpentine, etc.), Hardwood Distillation, Softwood Distillation, Charcoal, Boxes, Cross Ties, Poles and Piling, Posts, Mine Timbers, Fuelwood, Dyewoods, etc.

Consequently apart from its interest in giving up-to-date information on a multiplicity of forest industries the book has a special value for reference purposes. With this example of Professor N. Courtlandt Brown's work before us it is hoped that the "more exhaustive work or series of works" foreshadowed by the author will not be unduly delayed in their appearance. It will be clear from what has been written above that the book will be found useful by all utilization officers.

A. J. G.

VOLUME XLVI NUMBER 9

INDIAN FORESTER

SEPTEMBER, 1920

YIELD TABLES FOR SINGLE TREES OF DEODAR, KAIL, CHIL, SPRUCE AND SILVER FIR.

BY C. G. TREVOR, I.F.S.

INTRODUCTION.

The figures given here are the results of measurements recorded during the last 20 years in the Kulu Division, they have been compiled partly from the outturn of trees in departmental exploitation and partly from individual measurements taken for the purpose of these tables. In the case of the figures obtained from departmental conversion the figures of every tree have been scrutinized and any figures of doubtful value were rejected. In the case of special measurements the individual trees were selected immediately after felling. They were sawn up in the ordinary course of business and the outturn measured by a responsible officer at stump site. Owing to the large number of measurements on which these figures are based, over 8,000 trees in the case of deodar and 800 in the case of chir, the figures obtained, more especially in the case of deodar, may be considered quite sufficiently reliable, indeed these figures have been found perfectly applicable in practical working. In the case of outturn the diameters given are the marking list diameters over bark at 4½ feet, these diameters are the average of two measurements taken at

right angles, all fractions of an inch are excluded, so that the measurement may in actual practice be considered as giving an allowance for the bark. These tables are only intended to represent the actual outturn of the trees according to three quality classes. This is a matter which up till now has not been known and consequently it has been impossible to estimate the outturn to be obtained from the trees marked in any particular compartment or to estimate whether the rates paid by purchasers were in due proportion to the sizes of the trees sold. From the tables it is now possible to calculate accurately the exact outturn to be obtained from any particular coupe, whether the work is done departmentally or whether the trees are sold standing. The yield tables do not deal with crops but with individual trees; consequently they are not altogether suitable for calculating the rotation of even-aged crops, but as even-aged crops reaching maturity are not at present found in our forests these figures give sufficient information on which to base an approximate rotation suitable for present needs. As regards the ages given in the tables these have been compiled from a large number of ring countings; in the case of deodar, 1,200 measurements have been recorded on representative stumps, the average radius under bark having been taken and the necessary adjustment made for the thickness of the bark and the differences between stump and 4½ feet diameters, the time required for the seedling to reach stump height has also been calculated and the necessary adjustment made. It should be recognized that these ages only correspond with the diameters of individual trees. Because the table shows that a tree of 12 inches diameter is 57 years of age, it is not intended to imply that at this age a crop of 12 inch trees will necessarily be produced, but it is probable that a crop of this average diameter will be obtained. In a crop of the same age the diameters of the individual trees will vary considerably, and the diametrical increment will also vary with the site quality. These matters are not considered in these tables which are primarily of use for exploitation purposes. The ages are the average ages of Kulu trees, and this rate of growth will not necessarily apply

universally, but it is quite simple to substitute the particular rate of growth in any given division for the figures of this column. In the case of outturn the figures are of universal application, for a tree of a certain diameter and of certain quality, whether growing in Kulu or in any other locality, will give under similar condition of conversion an approximately equal yield. It is also necessary to remark that the yield in scantlings is that obtained from good conversion according to the ordinary standard of exploitation practised in the Himalayas. The logs are cross-cut with the saw, the logs are then roughly squared with the axe and scantlings sawn up, the convertible timber down to a diameter of about 8 inches is extracted, the tops of the trees give axe squared beams or rafters so that nothing of any use is left in the forest. Where such close utilization is not practised the figures of yield in scantling will not apply, but if the yields of these tables are not being obtained it is a clear sign that conversion has not reached its maximum efficiency.

CHAPTER I. -DEODAR.

The table below gives the allotment to quality classes according to height growth. The ages given are the averages for the Kulu Division—

Age.	Diameter class.	Quality class.		
		I	II	III
	Inches.	Height above Feet.	Height Feet.	Height below. Feet.
57	12	70	50—70	50
61	13	73	54—73	54
65	14	78	58—78	58
68	15	84	61—84	61
71	16	89	64—89	64
75	17	94	68—94	68
80	18	98	71—98	71
85	19	102	74—102	74
90	20	106	76—106	76
95	21	109	79—109	79
100	22	112	82—112	82
105	23	114	84—114	84
110	24	116	96—116	86
115	25	118	88—118	88
120	26	120	90—120	90

2. The following yield table shows the outturn in logs and scantlings for every inch of diameter from 12 inches—39 inches according to three quality classes, columns 10 and 11, show the outturn in logs and scantlings for the whole Kulu Division compiled from measurements of 8,000 trees. The figures for logs show the actual outturn of utilizable timber before sawing into scantling. The outturn in scantling is that actually obtained by the usual process of conversion used for the extraction of sawn timber in the hill forests of the Punjab. The standard wastage in converting logs into scantlings may be taken as 45 *per cent*. The ages given in column 2 for the various diameters are the average age of Kulu deodar compiled from 1,200 trees. Column 3 shows the mean annual increment in cubic feet of sawn *scantling* of trees of the diameters shown in column 1. These figures of increment are obtained by dividing the figures of column 11 by those of column 2. Column 12 shows the volumes of trees of the different diameter classes adopted for purposes of enumeration and the calculation of the annual yield. They are the averages of the figures of outturn in logs given in column 10, and represent the utilizable volume of wood in the trees of the various diamater classes and not the total volume of the tree. Column 13 gives the current annual increment of the trees of the various diameter classes shown in column 12 and represents the increments shown in column 10 between the first and the last figure of each diameter class divided by the number of the years spent in each class obtained from column 2. The figures of column 13 are used for calculating the current annual increment of the growing stock for the purpose of fixing the annual yield. The figures for the three quality classes are obtained from curves, those of column 10 and 11 are the actual averages of the total number of measurements. It is probable that both in height growth and yield the figures given for quality I are less than they should be. This is owing to the fact that very few trees of the finest quality were available for measurement.

Yield Table for Deodar.

1	2	3	4	5	6	7	8	9	10	11	12	13
Diameter in inches at 4½ feet.	Age	Mean annual increment in sawn scantling, Kulu average	Quality I		Quality II		Quality III.		Kulu average		Volume of trees for calculation of the yield	Current annual increment (trees)
			Logs.	Scantlings	Logs.	Scantlings.	Logs.	Scantlings	Logs.	Scantlings.		
		C ft.	C.ft.	C ft	C.ft	C ft.	C.ft.	C.ft	C ft	C ft	C ft.	C ft.
12	57	16	26	13	20	10	15	7	20	9		
13	61	18	31	15	24	12	18	8	24	11		
14	65	·20	37	18	28	14	21	9	28	13	II class - 30	1·27
15	68	·22	43	21	32	16	24	11	32	15		
16	71	·25	50	24	38	18	28	13	37	18		
17	75	·28	58	28	44	21	33	15	43	21		
18	80	·30	66	33	51	24	38	17	49	24		
19	85	·32	76	38	59	27	44	19	56	27		
20	90	·33	86	43	68	31	50	22	63	30	II ,, = 67	1·48
21	95	·36	100	48	74	35	56	25	70	34		
22	100	·39	114	54	82	40	63	28	77	39		
23	105	42	126	61	93	45	70	31	86	44		
24	110	·44	140	68	103	50	78	35	95	49		
25	115	·47	158	75	114	55	83	39	105	54	I ,, = 105	2·00
26	120	49	170	82	123	60	90	43	115	59		
27	127	·50	183	89	133	65	97	47	126	64		
28	135	·52	191	96	142	71	104	51	137	70	I ,, = 137	1·50
29	147	·53	200	101	150	77	111	55	147	76		
30	159	51	207	109	160	83	119	60	157	82		
31	171	·51	215	115	168	89	127	65	167	88	I ,, = 167	0·43 [Estimated only.]
32	205	·46	223	120	178	94	134	70	177	95		
33	..		229	126	185	99	142	75	187	102		
34	..		234	131	193	104	150	80	197	109	I ,, = 198	0·40
35	..	..	238	136	201	109	159	85	209	117		
36	..	..	243	141	208	114	168	90	221	125		
37	..	...	248	145	214	118	177	93	233	133	I ,, = 233	0·35
38	..	..	253	149	220	122	186	96	244	140		
39 & over.	..	..	258	153	226	126	192	100	255	150	I ,, = 260	0·30

CHAPTER II.—KAIL.

1. The table below gives the allotment to quality classes according to height growth. The ages given are the averages of the Kulu Division.—

Age.	Diameter class.	Quality Class		
		I	II	III
		Over.		Under
		Feet	Feet	Feet
42	12	65	45—65	45
45	13	70	48—70	48
49	14	75	51—75	51
52	15	80	54—80	54
55	16	85	57—85	57
59	17	89	60—89	60
63	18	93	63—93	63
65	19	96	66—96	66
72	20	100	69—100	69
77	21	103	72—103	72
81	22	106	74—106	74
87	23	108	76—108	76
91	24	110	78—110	78
97	25	112	80—112	80
103	26	114	82—114	82
109	27	116	84—116	84
115	28	118	86—118	86
121	29	119	88—119	88
129	30	120	89—120	89

2. The following yield table shows the outturn in logs and scantlings according to diameters in exactly the same way as the yield table for deodar. 759 figures of outturn were available and 626 figures of ages It was found by plotting curves that the figures for deodar were equally applicable to kail, and the actual deodar yield figures for the three quality classes were therefore adopted. The average quality of kail felled during the last eight years is better than the average quality deodar on which the deodar figures are based. In ordinary circumstances it may be found that a small reduction in these figures may be desirable but in the conditions found in Kulu this was not necessary :—

Yield Table for Kail.

1	2	3	4	5	6	7	8	9	10	11	12	13
Diameter in inches at 4½ feet.	Age	Mean annual increment in c. ft of sawn scantling.	Quality I. Logs.	Quality I. Scantlings.	Quality II. Logs	Quality II. Scantlings.	Quality III Logs.	Quality III Scantlings.	Kulu average. Logs.	Kulu average. Scantlings.	Volume of trees for calculation of the yield.	Current annual increment (trees).
		C ft.	C ft	C ft	C.ft	C ft.	C ft.	C ft	C.ft	C ft	C ft.	C ft
12	42	·24	26	13	20	10	15	7	20	10		
13	45	·27	31	15	24	12	18	8	24	12		
14	49	·29	37	18	28	14	21	9	28	14		
15	52	·30	43	21	32	16	24	11	32	16	III class = 31	1·41
16	55	·33	50	24	38	18	28	13	38	18		
17	59	·35	58	28	44	21	33	15	44	21		
18	61	·38	66	33	51	24	38	17	51	24		
19	65	·41	76	38	59	27	44	19	59	27		
20	72	·43	86	43	68	31	50	22	68	31		
21	77	·45	100	48	74	35	56	25	74	35	II „ = 71	1·75
22	81	·49	1 4	54	82	40	63	28	82	40		
23	87	·51	126	61	93	45	70	31	93	45		

Yield Table for Kail—(contd)

1	2	3	4	5	6	7	8	9	10	11	12		13
Diameter in inches at 4½ feet.	Age	Mean annual increment in c ft of sawn scantling	Quality I		Quality II		Quality III		Kail Average.		Volume of trees for calculation of the yield		Current annual increment (trees).
			Logs.	Scantlings	Logs	Scantlings.	Logs.	Scantlings.	Logs.	Scantlings.			
		C.ft.	C.ft	C ft	C.ft	C ft	C.ft	C.ft	C.ft.	C ft.	C.ft.	C ft	C.ft
24	91	·54	140	68	103	50	78	35	103	50			
25	97	·57	158	75	114	55	83	39	114	55	I	class = 111	1·66
26	103	58	170	82	123	60	90	43	123	60			
27	109	59	183	89	133	65	97	47	133	65			
28	115	·61	191	96	142	71	104	51	142	71	I	,, = 142	1·41
29	121	·63	200	102	150	77	111	55	150	77			
30	129	64	207	109	160	83	119	60	160	83			
31	137	65	215	115	168	89	127	65	168	89	I	,, = 169	1·1[illegible]
32	145	·65	223	120	178	94	134	70	178	94			
33	155	64	229	126	185	99	142	75	185	99			Estimated only 1·00
34		...	234	131	193	104	150	80	193	104	I	,, = 193	
35	..	.	238	136	202	109	159	85	202	109			
36	.	..	243	141	208	114	168	90	208	114			
37	..	..	248	145	214	118	177	93	214	118	I	,, = 208	·75
38	...	...	253	149	220	122	186	96	220	122			
39 & over	...	..	258	153	226	126	[illegible]	100	226	126	I	,, = 230	·50

CHAPTER III.—CHIL.

1. The table below gives the allotment to quality classes according to height growth. The ages given are the averages of the Kulu Division—Quality I is inferior to Troup's and corresponds more with Jerram's yield tables for Rawalpindi. –

Age.	Diameter class.	Quality Class.		
		I	II.	III
		Over		Under.
		Feet	Feet.	Feet.
51	12	65	45—65	45
55	13	69	47—69	47
60	14	73	50—73	50
65	15	77	54—77	54
71	16	82	57—82	57
77	17	86	60—86	60
83	18	89	63—89	63
90	19	92	66—92	66
95	20	96	69—96	69
103	21	98	72—98	72
111	22	100	74—100	74
117	23	102	77—102	77
123	24	104	79—104	79
132	25	106	81—106	81
141	26	107	82—107	82
150	27	108	83—108	83
160	28	109	84—109	84
170	29	110	85—110	85

2. The following yield table shows the outturn in logs and scantlings for every inch of diameter in exactly the same way as for deodar. The table is based on the measurements of over 750

2

trees and the ages obtained from 1,038 ring countings. The table excludes quality 4 which was not represented in Kulu :—

Yield Table for Chil.

1	2	3	4	5	6	7	8	9	10	11	12	13
Diameter in inches at 4½ feet.	Age.	Mean annual increment.	Quality I		Quality II		Quality III.		Kulu average		Volume of trees for calculation of the yield.	Current annual increment (trees).
			Logs.	Scantlings.	Logs.	Scantlings.	Logs	Scantlings.	Logs	Scantlings.		
		C.ft	C.ft	C.f	C.ft	C.ft	C.ft	C.ft	C.ft	C.ft	C.ft.	C.ft.
12	51	·06	16	6	12	4	8	2	13	5		
13	55	·10	19	8	14	5	9	2	15	6		
14	60	·13	23	10	16	6	10	3	18	8	III class = 22	0·88
15	65	·17	28	14	19	8	[illegible]	4	22	11		
16	71	·[illegible]	35	18	22	10	15	6	29	14		
17	77	·23	43	22	26	13	18	8	36	18		
18	83	·26	52	27	32	16	21	10	43	22		
19	90	·28	62	32	38	19	24	12	50	26		
20	95	·32	72	38	45	23	28	14	60	31		
21	103	·35	84	44	52	28	32	17	70	36	II " = 66	1·44
22	111	·38	96	50	60	33	36	20	80	42		
23	117	·41	110	57	69	38	40	23	92	48		
24	123	·44	124	64	80	43	45	26	104	54		
25	133	·46	136	72	90	48	52	30	116	61	I " = 117	1·44
26	141	·48	150	79	100	54	60	35	130	68		
27	150	·50	164	86	110	60	68	40	144	75		
28	160	·51	176	93	120	66	76	44	156	82	I " = 157	1·30
29	170	·53	188	100	130	71	84	48	170	90		
30	180	·54	198	106	140	77	92	52	182	98		
31	190	·55	207	111	149	83	100	56	194	105	I " = 193	1·10
32	200	·56	215	116	158	88	108	60	204	112		[Estimated only].
33	...	...	222	121	166	93	116	64	214	118		
34	...	...	229	126	173	98	122	68	221	125	I " = 224	1·00
35	...	...	235	131	179	103	128	72	235	131		
36	...	...	240	135	185	108	134	76	240	135		
37	...	...	245	139	190	113	139	80	245	139	I " = 245	0·90
38	...	...	250	143	195	116	142	84	250	143		
39 & over.	...	...	255	146	200	120	145	87	255	146	I " = 260	0·50

CHAPTER IV.—SPRUCE AND SILVER FIR.

1. Owing to the fact that these two trees were not separated in the enumeration and that they will be dealt with together under the name of fir both species have been combined into one table. The table below shows the height growth of both species and the provisional allotment to quality classes. The ages given are the average ages of both species. This table is merely provisional until more details are available:—

Age	Diameter class.	Quality Class I	II	III
		Over. Feet.	Feet.	Under Feet.
92	18	100	60—100	60
98	19	104	63—104	63
103	20	108	67—108	67
107	21	113	71—113	71
112	22	117	75—117	75
117	23	121	78—121	78
122	24	125	81—125	81
128	25	128	84—128	84
132	26	131	87—131	87
139	27	134	89—134	89
144	28	137	91—137	91
150	29	140	93—140	93
155	30	142	95—142	95
161	31	144	96—144	96
168	32	145	97—145	97
...	33	146	98—146	98
...	34	147	99—147	99
...	35	148	100—148	100
...	36	149	...	...
...	37	150	...	...
...	38	...	...	...
...	39	...	...	...

2. The following yield table shows the outturn in logs and scantlings for every inch of diameter. Owing to the fact that only 300 of figures of sample trees were available due to the difficulty of finding absolutely sound trees free from any rot or discolouration of the heart-wood it has not been possible to compile the table showing the yield according to three quality classes. The ages of spruce and silver fir have been separately given in columns 2 and 3 and the average age of the two species in column 4. It is on this average age that the figures of the

mean annual increment in column 5 and the current annual increment in column 10 have been calculated. The table probably represents fairly accurately the yield of quality class I :—

Yield Table for Spruce and Silver Fir.

1	2	3	4	5	6	7	8	9
					Kotu Average.			
Diameter in inches at 4½ feet.	Age of spruce.	Age of silver fir.	Average age of the two species.	Mean annual increment in c.ft of sawn scantling.	Logs.	Scantlings.	Volume of trees for calculation of the yield.	Current annual increment (trees).
				C.ft	C.ft	C.ft	C.ft.	C.ft.
12	57	73	65	·15	20	10		
13	61	80	70	20	26	14		
14	63	86	75	·24	32	18	III class =35	1·39
15	69	90	79	·26	38	21		
16	73	96	84	·29	44	25		
17	77	100	88	·32	52	29		
18	81	104	92	36	60	34		
19	85	112	98	·40	70	40		
20	89	118	103	·44	82	46	II ,, =90	2·64
21	93	122	107	49	96	53		
22	97	128	112	·54	110	61		
23	101	134	117	·59	126	70		
24	105	139	122	·65	144	80		
25	111	146	128	·70	162	90	I ,, =162	3·60
26	115	150	132	75	180	100		
27	120	158	139	·79	200	110		
28	125	164	144	·81	220	118	I ,, =219	3·27
29	129	172	150	·84	236	126		
30	133	178	155	86	250	134		
31	137	186	161	·87	264	141	I ,, =263	2·00
32	143	194	168	·87	276	147		
33	150	...	...	...	288	153		Esti-mated
34	155	...	...	...	300	159	I ,, =299	1·50
35	160	.	...	...	310	165		
36	165	...	...	...	320	170		
37	170	...	...	...	328	175	I ,, =328	1·00
38	175	...	...	...	336	180		
39 & over	183	...	...	...	344	185	I ,, =350	·50

CHAPTER V.—CONCLUSION.

It will be of the greatest advantage if Forest Officers will collect all the figures they can for the outturn of individual trees of all species and diameters. More especially figures for kail, chil and fir are required so that the tables given may be amended in the light of further knowledge. These tables do not pretend, even in the case of deodar, to be final. They are merely put forward to be used until something better can be prepared. However they represent a considerable advance in knowledge and may safely be used in the compilation of working plans for forest divisions more or less similar to Kulu. No better figures will be obtained during the period occupied in the preparation of a plan and much time and labour will be saved by adopting these figures, which apart from the measurements have taken a year to compile.

FORESTRY WITH THE B.E.F.

BY J. D. MAITLAND-KIRWAN, I.F.S.

(Concluded.)

The Forêt de Roumare, to which I was transferred as A. F. D. C. O. in August 1918, was situated on the right bank of the Seine immediately south of Rouen. It occupied the high ground overlooking that river, and the country all round was lovely, and the views of the river as it wound its way towards Havre were superb. There can be few lovelier types of river scenery in Europe than the valley of the Seine, here flanked by chalk cliffs crowned with forests of beech or pine, among which are dotted ancient chateaux and ruined abbeys there running by orchards and meadow lands which slope gently up to the hills beyond. It was difficult to decide which season provided the more beautiful picture, spring with its lovely orchards of pink and white blossom, or autumn with its wonderful forest tints.

Not the least interesting feature of the country in which the Lines of Communication forests were situated was its close association with English History. Crécy of course is a name familiar to every English schoolboy, and the little village of Lyons la

Forêt was the scene of the demise of that King whose only claim to fame that I can remember is that he died there after partaking too heartily of lampreys at the Abbey of Mortemer close by. The ruins of the old abbey are in the forest, and the dwelling-place adjoining it is still occupied. Rouen of course revived many memories of the English occupation, and the Forêt de Roumare seemed a connecting link between the past and the present. A broad line was cut straight through the forest which must have been some twelve miles long, and by standing on the highest point in the line it was possible to see at one end of it, on the opposite side of the river, the ruined chateau of Robert the Devil, where William the Conqueror spent a great part of his childhood, and at the other end the modern chateau of Montigny, where the present King and Queen stayed on their visit to France during the war.

Roumare forest was composed of beech and pine, the pine being mostly Scotch but with a considerable admixture of Maritime in some places. It was divided into five felling series, of which the fifth series was worked differently to the other four. The first four series contained blocks of beech and pine, but although there was a considerable area of pine and the beech was only of moderate quality, there was no separate scheme of management in force for the pine. These series were worked under the Shelterwood Compartment System, with a rotation of 150 years for the beech and 85 for the pine, and the Inspecteur told me that the idea probably was gradually to convert the pine in these series into beech forest. The fifth series was pure pine forest and was worked under the same system, but with a rotation of 75 years and a regeneration period of 15 years, each periodic block being divided into 15 coupes. The regeneration was excellent, and the system evidently a great success.

I will not deal in detail with the work at Roumare, but will content myself with mentioning one or two points in which it differed from other forests. Before Major Hellmuth and I arrived there as F. D. C. O. and A. F. D. C. O. respectively, a Forestry Company R. E. had been carrying out exploitation on a small scale,

and they apparently very much resented the direction of the work being taken out of their hands, and this tended to make things rather uncomfortable. The camp was only a makeshift sort of arrangement, for the intention was to erect a permanent camp on another site, an intention which however was never carried out. There was at first no labour except the personnel of this R. E. Company and they were chiefly engaged in turning out telegraph poles, but as it had been decided to install two P. O. W. Companies we had to construct camps for them. One of these Companies did eventually come into residence, but the Armistice intervened before the other one had been sent. There was no saw mill, but after some time we succeeded in getting a small mill at each end of the forest, and they were chiefly employed on turning out sleepers. Nor at first was there any Horse Transport, which made things very difficult, for we had not sufficient Décauville to enable us to clear the coupes properly. We eventually built a camp for the H. T., but this took some time, and in the meanwhile we had to get along as best we could. Incidentally I got into hot water with the French for not felling the coupes in an orderly manner, for when the P. O. W. Company at last turned up I made them fell narrow strips along the roads running through the coupes which had been allotted to us, with the idea of limiting the distance over which the material had to be man handled to the road side. There was also very little Motor Transport available either for the Inspecting Officers or for the transport of material to the railway, and it was very difficult to get sufficient trucks in which to send away material when we did get it to the station. Nor, until the last few weeks, were there any telephones, a blessing in some ways, but a very great nuisance in others, and all these difficulties combined to prevent the work running as smoothly as it might otherwise have done. In order to speed things up the F. D. C. O. received instructions to work out a scheme for laying down a railway through the forest, as had been done at Crécy, and for connecting this railway with the river bank by a system of timber slides. The idea was to construct a wharf at the riverside and to send the material by barge to Havre, which was a large distributing

centre, and so solve the difficulty of obtaining sufficient rolling-stock at Rouen. The preliminary surveys were made and the initial difficulties, of which there were many, successfully overcome, but the Armistice eventually knocked the scheme on the head.

Three special features in connection with this forest may be mentioned, the supply of telegraph poles, the employment of civilian labour, and the effect of the Armistice on the work in Roumare and other forests.

Our work lay entirely among the pine coupes, although we should also have cut a number of beech coupes had not the Armistice intervened. Although the work was at first on quite a small scale, it was none the less important, for Roumare was the forest on which the L. of C. Group chiefly relied for the production of telegraph and telephone poles. Our armies had now launched the offensive which was destined to finish the war, and as they advanced, and the lines of communication consequently increased in length, the demand for this class of pole became more and more insistent. The Royal Engineers were strict about telegraph poles being cut exactly to specification, and these specifications differed according to the objects for which they were required. There were altogether seven classes of heavy, or "A," poles, and four classes of light, or "B," poles. "A" poles varied in length from 24 to 60 feet, and a maximum and minimum diameter at the tip under bark was prescribed, as well as a maximum and minimum diameter 5 feet from the butt. 30 foot poles, for instance, of which we sent away large quantities, had to have a maximum diameter at the tip under bark of 6 inches and a minimum of 4 inches, while their maximum and minimum diameters at 5 feet from the butt were $9\frac{1}{2}$ and 7 inches respectively. The "B" poles were measured on the same principle, except that the butt diameters were taken at 3 instead of 5 feet from the butt. In addition to these eleven classes we turned out two classes of telegraph poles for the French, which were measured on the same principle except that the diameter measurements were taken over instead of under bark. It will be appreciated that very reliable men were required to mark off the

felled trees into different lengths according to the various classes of poles required, for it must be remembered that in addition to telegraph poles a large number of sleepers and ordinary round poles, as well as a considerable quantity of firewood, had to be supplied. When the P. O. W. Company arrived, therefore, it was necessary to detach a number of men from the R. E. Forestry Company working party to teach them the work and to check all their measurements, and while instructing the Germans one of these men was unfortunately killed by a falling tree.

These poles were too long and heavy to be transported in lorries, so trailers, drawn by traction engines, had to be requisitioned, and it was a problem to keep them constantly at work. There was comparatively little space for a dump at railside, and when the dump became full up owing to the non-supply of railway trucks for a day or two the trailers had to remain idle, and bitter complaints would be received from the R. A. S. C. When however a special train of 20 or 30 trucks arrived to take away a load the dump got very low, and frantic efforts had to be made to replenish it in order to avoid complaints from the railway authorities that although they had provided trucks we had been unable to find loads for them.

Before the arrival of the P. O. W. Company a certain amount of civilian labour was employed in Roumare. Civilian labour was usually supposed to be much less trouble than any other class of labour, as the men were put on piece-work and paid at certain rates per unit of material brought to roadside They could work any hours they chose and very little supervision was required, for payment was conditional on the coupes being properly cleaned up. In Roumare, however, civilian labour caused a good deal of trouble. A contract for the exploitation of several coupes was given to a Frenchman who had been all through the battle of Verdun and had, I believe, been wounded seven times during the war. He was a good little chap and did his best, but he always seemed to be having trouble with his men. He employed chiefly Spaniards and Belgians, and the Spaniards were lazy and unsatisfactory in every way. They continually turned up very late and

often, especially on wet days, refused to come at all. The consequence was that we constantly found ourselves short of material to send away, the labour suffered through not earning sufficient money to satisfy them, and the contractor had a worrying time trying to propitiate us on the one hand and his labour on the other. All the material turned out by the civilians had to be measured up in the presence of one of our representatives and one of theirs, and at first this used to be done daily, for we were living a hand to mouth existence and had to send away the timber almost as soon as it was cut. As the exploitation became more systematic, however, and the outturn consequently increased, we were able to introduce weekly measurements, and this was a great saving of time and trouble.

I have said that payment was only made on condition that the coupes were properly cleaned up, and this entailed not only gathering all the brushwood into heaps and burning it, but also the carbonizing of the stools. The pine weevil was a dreaded pest in this and other similar forests, and the French insisted on all stumps having the bark removed and then being thoroughly carbonized. This was effected by piling brushwood on the stools and setting fire to it, but the process took longer than might have been expected, and was especially difficult in wet weather.

Two other forests were subsequently put under the charge of the F D C. O., Roumare, a private forest on the opposite bank of the Seine belonging to the Duc de Noailles, the right to exploit which had been purchased by the British Army, and a State Forest, Forêt Verte by name, situated close to Rouen I was put in entire charge of the latter forest in addition to my duties as A. F. D. C. O., Roumare, but the distance of this forest from my headquarters made supervision a very difficult matter. Both these forests were worked by civilian labour, and in Forêt Verte, the only one with which I was really concerned, the timber was cut up in an electric saw-mill belonging to a civilian with whom we had a contract. Forêt Verte was a beech forest, and evidently in a favourite picnicking place for the inhabitants of Rouen. Here again there was a good deal of trouble with the coupe

contractor, who would not clear up the coupes as he went, and when eventually stern measures were taken to make him fulfil the terms of his agreement he threw up the contract. The saw-mill contractor was also rather a worry. According to the terms of his agreement he had to be supplied with a minimum amount of timber by the coupe contractor daily, and was paid at certain rates for every truck of material he sent away. Difficulties of course arose when rolling-stock was not forthcoming, and this led to bad blood between him and the *Chef de Gare*, and it became continually necessary to placate both parties, no easy matter when the contending parties appeared to speak an entirely different dialect of French to myself. Personally I found civilian labour, granted that it needed less supervision, more trouble than it was worth, and we had eventually to bring Germans over from Roumare in lorries to finish off the work in Forêt Verte.

No one will ever forget the news of the Armistice on November 11th, 1918. I had been over to Forêt d Eu the previous day. but motored back to Rouen next morning, and it was interesting seeing the villages on the way. Some of them seemed either to have heard or to have anticipated the news and were gay with flags, while others appeared as sleepy as usual. The little town of Neufchatel was *en fete* with flags everywhere and cheering crowds in the streets, and we expected to see great scenes when we reached Rouen. Strangely enough however the news had not yet got through, and there were no signs of rejoicing I went to call on a cousin who was working in one of the Soldiers' Homes, and as I was standing on the balcony of the Home overlooking the river suddenly all the vessels began to blow their sirens, and the guns of the garrison aiding their music to the tumult told us that the great moment had come at last. The scenes which followed were unforgettable. Flags which had been stored up for months in anticipation of the event appeared as if by magic the streets filled with cheering crowds; lorries full of tommies, poilus, W. A. A. C's and any one who could find room on any part of them appeared from nowhere, and the fun became fast and furious. Many instinctively made for the Cathedral and Churches

where crowded impromptu services were held, and the occasion was one of such spontaneous rejoicing as none of the subsequent artificial "Peace Celebrations" have provided. The British seemed to show their feelings even more than the French, and I read an article in one of the French papers saying that the idea that the British were a phlegmatic race was gone for ever.

The effect of the Armistice on our forest work was not immediate, for large supplies of timber were still required. Demobilization however soon began, and among others Major Helmuth, F.D.C.O of Roumare, left for Canada. About this time I went on leave, and on my return I was told that a new Major had arrived to take his place, and this proved to be none other than Major Courthope, *I.A.R.O., I.F.S.* Major Courthope had done valuable work in helping to organize the operations in the L. of C. Forests early in the war, and had subsequently been attached to a British Infantry Regiment at the front where he was wounded. After recovering he was sent back to India but was recalled to service under the Forest Directorate, and arrived in France after the signing of the Armistice.

Soon after Major Courthope was installed as F. D. C. O., Roumare, the work of closing down operations commenced. Fellings were stopped, or were continued up to a line approved of by the French, but this of course by no means brought our work to an end, for there were thousands of tons of unconverted timber in this and other forests, as well as an enormous quantity of sleepers, scantlings, poles, fuel, and other material ready for despatch. A certain amount of the latter was of course still required by the Armies and had to be sent away as usual, but the bulk of it was not needed, and the question at once arose as to what should be done with the unconverted timber. At first we had orders to saw it up into scantlings suitable for sale, but eventually the French agreed to take over all the timber we had cut, whether converted or not, at rates to be mutually agreed upon. Everything therefore had to be brought to roadside and a complete inventory made. This material had to be neatly stacked in proper classes, each stack being labelled to show the number of pieces and its

cubic contents, and it was decided that one British and one French Officer should go round the L. of C. Forests to check the accuracy of the inventory, preparatory to the material being taken over by the French. Major Courthope was the British Officer selected for this work, and he toured the forests in company with the French representative. The French Officer was inclined at first to go too much into detail, and it looked as if the work would take a considerable time. He eventually became more reasonable, however, and our estimates of the contents of logs and stacks were, I believe, accepted with very few changes In some forests a considerable amount of wood was retained by the British for the supply of fuel, etc., to the troops which still had to be kept in France, and several Forestry Corps Officers remained to arrange for its despatch after the rest of us had been demobilized and the Directorate broken up

The disposal of wood was by no means the only problem which the Forestry Corps had to face. Camps had to be dismantled, saw-mills, machinery, tools and all manner of stores had to be disposed of, roads had to be put in order, and in some cases large areas had to be artificially regenerated. Huts and machinery were as far as possible sold, but the disposal of these and other stores were, I believe, eventually arranged for by a "Disposals Board" which was set up to deal with all matters of this kind. These clearing up operations were perhaps the most unpleasant part of our work. While the fighting was proceeding keenness never flagged, and there was the daily feeling of satisfaction that we had despatched so many more tons of material to the front. After the fighting was over although the keenness remained it was directed into other channels, and the minds of men and officers alike were set not so much on turning out a maximum day's work as on getting home as quickly as possible. The demobilization muddle upset everybody Orders on the subject were issued only to be superseded by fresh orders a day or two later, and these in turn by others, until no one seemed to know what the intentions of the authorities really were. Men who thought they had every claim to early demobilization saw

those who they thought had no claim at all released before them, and they naturally became discontented, especially as the departure of those men threw more work on their own shoulders The fact is that, spurred on by injudicious newspaper articles, Government tried to carry out the process of demobilization too rapidly, and the attitude taken up by a certain section of the Press rendered more difficult what in any case would have been a very difficult operation. I saw a cartoon in one of the papers portraying a British soldier standing on the quay of one of the ports. He was bound hand and foot with red tape and was looking longingly at a steamer, with "Blighty" on it in large letters, which had just left the harbour with a number of returning exiles on board. Pictures and articles of this tenour made the men think that they were being kept away from their homes unnecessarily and did infinite harm. As a matter of fact numbers of men when eventually they were demobilized found the conditions at home quite otherwise than what they had pictured, and would have been only too glad to have been able to get back again.

I will conclude these articles by giving a few notes on lectures on Forestry delivered in the L. of C. Forests, and by describing the resowing of areas cleared by our troops.

I have in a previous article given some account of the personnel of the Forestry Corps and have pointed out that in the case of the Labour Companies there was, to begin with, a complete lack of knowledge, not only of forestry questions generally, but of such necessary matters as how to fell trees, how to measure timber, and so on. Colonel Oldham, Deputy Director of Forestry, therefore arranged that all Labour Company Officers should undergo a course of training for a week in order that they might be taught the elements of their work, and so might be in a better position to instruct their men. The course took place in the Forêt d Eawy, a large beech forest in the neighbourhood of the little town of St. Saens, and comprised such subjects as Sylviculture and Forest Management, Felling and Conversion Timber Measurement, Charcoal making, and Saw-milling. The course was proceeding while I was at Roumare, and I had

to go to Forêt d'Eawy one day a week to lecture in Sylviculture and Management. The object of these lectures was chiefly to give the officers more interest in their work by explaining the system under which their own particular forest was managed, and thus helping them to understand the reasons for the various restrictions imposed by the French Forest Officers. The lectures were usually delivered in the morning and the afternoons were devoted to excursions in the forest. I found the officers as a rule very interested in the subject, but most of them had no idea that there was such a thing as systematic forest management, and some had absolutely no experience of country life. One of them even said that he had no idea that it was possible to tell trees apart by their leaves, and very few of them had any knowledge of the different species. I remember taking one of the classes up to a willow and asking if any one knew what it was, but after various guesses, which included a larch and a sycamore, they had to give up the conundrum.

The Forêt d'Eawy was managed under the Shelterwood Compartment System, but the method differed from that ordinarily employed, in that there was no division of the area into Periodic Blocks. I have no note regarding the management, and cannot remember details; the salient feature was, however, that the whole forest was divided into a certain number of compartments, the compartments in each felling series being classed in three groups according to whether the crops in them were young, middle-aged, or mature and therefore ready for regeneration. The regeneration areas were thus scattered about the forest instead of forming more or less compact blocks, but in other respects the working did not differ materially from the system as normally applied.

After the declaration of the Armistice an Army Education Scheme was formulated with the double object of giving officers and men something more interesting to think about than the ordinary routine, and of providing them with preliminary instruction in subjects which would be of use to them in the vocations they intended to follow on their return to civil life. Among the

many and varied courses prescribed was a Forestry course in the L. of C. Forests. It was decided that this should last three weeks, the first week being spent in Forêt d Eawy, the second in Forêt de Brotonne a forest about which a few notes will be given later), and the third week in the Forêt de Lyons, about which I have already spoken. An officer was appointed as Instructor in each of these forests and in the first two instruction was given in Sylviculture, Botany, Surveying, etc. I was given charge of the course in the Forêt de Lyons and gave instruction in Forest Management, while two officers who were appointed to assist me lectured on Utilization and Saw-mills. The classes went from forest to forest in motor lorries, and quarters and lecture rooms to accommodate them had to be built. Three years is the length of instruction usually considered necessary for the education of a Forest Officer in Europe, and it will readily be understood that to turn out the "Compleat Forest Officer" in three weeks was a somewhat difficult task. The time however was sufficient to indicate the lines which Forest education should follow, and to give those who were keen a real interest in the subject. The difficulty of preparing a suitable course of lectures was enhanced by the very mixed nature of the classes. They comprised both officers and men, ranging from the Staff Major in all the glory of his scarlet apparel to the humble private, and from the man of high intelligence and intellectual attainments to the man who appeared to have a doughnut in the place where his brain ought to have been. Add to this that some of them were very keen on the subject, that others had come merely for the joy ride, and that others again had been sent on the course entirely against their will and it will be apparent that the lot of the lecturer was not all jam. I must say however that the great majority took the course quite seriously, and appeared very grateful for any help they were able to get. A number of them were anxious to get posts in the new British Forestry Service, and reports had to be made on these men stating whether or not they were likely to make suitable candidates. In making these reports I used to take into consideration what the man's civil vocation had been. In the first class there were five

officers, whose civil employments were respectively Commissionaire (and a very typical "chucker out" he looked), Electrical Engineer, Schoolmaster (a very dense old Lieutenant), Rubber planter, and Nurseryman, and twenty men composed of two regular sergeants, one Timber merchant's clerk, five Foresters, one Horticultural Instructor, three Gardeners, one Saw-miller, one Steward, one Manual Training Instructor, one Architect, one Steel erector one West African Trader, one Farmer, one Carpenter, and one Haulage Contractor's representative. I lectured as fully as possible on Mensuration, and on Forest Organization with special application to the Forêt de Lyons, and excursions were made to different parts of the forest. Practical instruction was also given in the measurement of trees and standing crops, and most of them entered keenly into the work. There were however exceptions. I remember one day telling a man to measure the height of a tree, and his answer was "Please, sir, I ought not to be on this course at all." It appeared that his guiding star in life was a desire to know something about machinery, and when the Army Education Scheme was mooted he felt that at last his brightest hopes were to be realised. They were however doomed to disappointment, for his C. O. had insisted on his going on the Forestry course in order to make up the numbers.

The course would have been a more pleasant one had circumstances allowed of its being held in the summer instead of in the months of January and February, when the cold was appalling. Heavy snow constantly interfered with the transport, and as the quarters which had been erected for the classes were built of green wood they would probably have been cold and damp even in summer. Each hut was provided with a stove of an abominable pattern, which was difficult to light, and still more difficult to keep alight even when the supply of firewood was sufficient. The experience however provided a valuable object-lesson in the shrinking properties of green timber under the influence of heat, but the fact that we were able to get a splendid view of the surrounding country through the walls and could study the nature of the soil through the floor hardly compensated us for the agonies of cold we underwent.

Most of the forests which we exploited were regenerated naturally either by seed or coppice shoots, and needed no artificial restocking. Certain areas, however, had been clear cut or nearly so, either in the natural course of felling operations or for the purpose of clearing sites for the erection of camps and such areas the French required us to sow up There were certain areas of this class in Lyons and Roumare, but the largest ones were in the forests of Brotonne and Rouvray, and I was put in charge of the work there. The Forêt de Brotonne was a large forest on the left bank of the Seine, just opposite the pretty little riverside town of Caudebec, which was a favourite summer resort. There was no railway on the left bank of the Seine passing sufficiently close to the forest to be of much service for the transport of timber, so all the material extracted by the British Army was despatched by barge to Havre, whence it was sent on to its final destination. The forest was divided into ten felling series, series I containing Scotch Pine, and the remaining series beech. The beech series were worked under the Shelterwood Compartment System on the usual lines, the rotation being 150 years, the regeneration period 30 years, and every compartment being thinned three times during the period at intervals of 10 years. It was in the pine area, however, that sowings had to be carried out. The rotation for the pine in series I was 90 years and the regeneration period 10 years, there being thus 9 periodic blocks. The Shelterwood Compartment System being the one in force natural regeneration was of course the rule, but regeneration had very largely failed in the first block where the final fellings had been completed, owing, I believe, to the occurrence of a large fire. In periodic block II where our work lay we had left only about 14 seed bearers per acre instead of 32 which the French usually left, and we were therefore required to resow this area. 158 acres had already been treated in this way during 1918, and about the same area remained to be dealt with.

The sowing was done in patches a foot square. They were first dug up with a spade or pick to a depth of 4 to 6 inches, and then

raked over. Two drills were then made in this seed bed with a drill-mould consisting of a piece of wood flattened on the under-surface to which two cross pieces were nailed. In each patch 50 to 100 seeds were sown, and after sowing the drills were raked over. The patches were about 4 feet 4 inches (1·30 metres) apart, there being thus some 2,320 patches per acre, and 4 pounds of seed were allowed for every acre. In order to ensure the proper spacing of the patches a flexible wire with marks at intervals of 4 feet 4 inches was used. Before the seed was sown the stumps of the pine which had been felled had to be treated in the manner already described.

I went to Brotonne at the beginning of April and started work. The patches had been dug some time before, so all that was necessary was to prepare the seed bed and sow the seed. The work was to be done by German labour, and I was given a British corporal and one or two men to assist me. Effective supervision was the chief difficulty, as it was quite possible that the Germans would deliberately neglect to distribute the seed evenly, putting a large quantity in some of the patches, and none at all in others. In order to ensure the even distribution of the seed the following procedure was adopted. The seed was divided into bags of 10 lbs. each, and as empty bully beef tins were used for the actual sowing work experiments were made to find out how many of these tins of seed were contained in one bag, and the number of patches to be fed by one tin was thus calculated. Suppose, for instance, that a 10 lb bag was found to contain 20 tins full of seed, then since 10 lbs was the quantity allowed for one acre or 2,320 patches, one tin would have to feed 116 patches. The sowers were given instructions accordingly, and they very soon learned to put just the right amount of seed in each patch. It was very important that, too much seed should not be used, for it was very difficult to obtain, and we had only just sufficient in hand to complete the area. Owing to the rapidity with which the work proceeded it was necessary to have some device which would enable the Inspecting Officer to see at a glance whether the seed was being properly sown or not, for Scotch pine seed so

resembles earth in colour that it is difficult to distinguish it from the latter. The bags of seed were therefore first soaked in water, and then emptied out and sprinkled with chalk , the seed thus became white, and a glance at the patches was sufficient to show whether it was being properly sown or not.

As regards the organization of the work the men were divided into parties of 20 to 30 each and worked in four rows. 28 men was a convenient number for a party, of which the first row would consist of 12 men with rakes who would prepare a seed bed in each of 12 patches; they would be followed by a row of 4 men with drill-moulds who would each make drills in 3 beds, and these in turn by a third row of 6 men who would sow the seed in the drills thus prepared. A fourth row of 6 men with rakes would bring up the rear and rake over the drills and thus complete the work.

Owing to the difficulty in supervising the sowing of so many pits I was loth to put the men on task work, being afraid that the temptation to hurry over the work would lead to quality being altogether subordinated to quantity. At first we only started with a few men, but these were gradually increased to over 100. The first day the average number of patches per man completed was 263, and although this was subsequently increased I soon saw that I should have to introduce task work if the area was to be completed within a reasonable time. I therefore applied for a larger supervising staff, and set a task of 500 patches per man per day, which proved quite satisfactory, the area being completed in about 10 days.

From Brotonne I moved to Rouvray, a large pine forest in the neighbourhood of Rouen which the Canadians had exploited a year or two previously. The areas here had been clear cut, and a good deal had already been resown, but an area of about 520 acres remained to be taken in hand, which meant the sowing of over 1,200,000 patches, most of which had previously been dug. The exploitation of the areas in this forest allotted to the British Army had been completed some time previously, and there was thus no labour in the forest, no camp in which to house it, and no

water near the area which had to be resown. I therefore arranged with the R. E.'s to construct a camp, with the R. A. S. C. to bring a lorry load of water daily, and with the Labour Authorities to supply about 150 Chinamen to carry out the work. My own staff was housed in the camp, but I lived in Rouen and went out by car daily. The Chinamen soon took to the work, and after the experience at Brotonne I was able to do it more economically. I dispensed altogether with the drill-moulds, as they appeared unnecessary, and the men in the first row were instructed to make the drill by pressing the backs of their rakes into the seed beds after they had prepared them. I set a task of 600 patches per man per day, and worked with four parties of 32 men each, who thus sowed 76,800 patches, or about 33 acres, every day, and the area was completed in under three weeks. The French appeared to be quite pleased with the work done by the Chinamen, but as a prolonged drought followed the sowing complete success may not have been attained.

Although there was plenty of work in France there were certain amenities as well, and one of these was "Paris leave," which officers and men were allowed to take from time to time. I was able to avail myself of this a month or two before I left France, and it was well worth it The crowds in Paris were a wonderful sight during the war, and there were few more interesting experiences than to sit outside the Café de la Paix and watch them pass. Faces of every type and uniforms of every description testified to the number of nationalties represented and made up a picture which it will not be easy to forget.

I also made an interesting trip in company with Major Courthope through the devastated areas. Starting from Rouen we went by way of Blangy to Amiens, which was less seriously damaged than I had imagined. Soon after leaving Amiens we entered the devastated areas, where the fight had surged backwards and forwards for close on four years. Passing through Albert and Bapaume we made our way *viâ* Arras to the Vimy ridge, and thence by way of Lens to Lille, were we spent the night. The awful desolation and ruin everywhere have been

described by pen and picture, but can never be adequately realized by those who have not seen them. The little wooden crosses everywhere told a pitiful tale, and the whole area seemed to be one vast cemetery. Next day we went on through Armentières and Bailleul to Ypres, and every one who sees the town, or what remains of it, must realize in a way he never did before the astonishing gallantry of the wonderful troops who held it month after month, and year after year, and so barred the way to the Channel ports. Commanded as it is by ridges which were for a long time in possession of the Germans, and surrounded by country of so marshy a character that all the shell holes were full of water, it looked a place impossible to hold. Leaving Ypres we passed close to Mount Kemmel and hurrying through little Belgian towns and villages arrived at Mons, where we stayed a day or two owing to the breakdown of our car, from Mons we returned through Cambrai, Bapaume, and Amiens to Rouen. In Mons we heard interesting stories of the German occupation, but the town itself was undamaged, and the country showed few signs of war until we approached Cambrai and then once more traversed the devastated area.

After the completion of the work at Rouvray I returned to England, but not before I had had one more experience of Army methods. The War Office had decided that the wives of officers and men of the Expeditionary Force should be allowed to join their husbands in France, and an order to this effect was published. This of course entailed the filling up of various forms, but having now some knowledge of Army ways and knowing the delay that would inevitably occur I telegraphed my wife to go to London and sit on the steps of the War Office until she got permission to come. This she did and managed to get her passport without much difficulty. After she had been in France some time she received a letter saying that it had not yet been decided whether or not wives were to be allowed to join their husbands, but that she would be informed in due course when the matter was settled. After our return to England my wife received forms which she was told to fill up in case she wished to join her husband.

I was finally demobilized in the middle of May 1919, and although glad in many ways to be free once more I left the Army with considerable regret. My time in France, although very strenuous and sometimes unpleasant, had been full of varied experiences which I would not have missed for anything, and I was very proud to have been associated with the Forestry Corps, of whose work I have tried to give a glimpse in these articles. That work was by no means spectacular, far from it, but of its usefulness there can be no doubt, for it was acknowledged by no less a person than His Majesty the King. During his last visit to France His Majesty visited the Corps, and a photo of him riding through one of the forests on a Décauville truck with Lord Lovat at his side appeared in the illustrated papers. In a message to his troops which he published on leaving France he paid a handsome tribute to the work done by the Forestry Corps, and the fact that their efforts had not passed unrecognized by His Majesty was deeply appreciated by all ranks.

(Finis.)

THE CAUSE OF SPIKE IN SANDAL (*SANTALUM ALBUM*, L.).

BY P. S. JIVANNA RAO, M.A., AGRICULTURAL COLLEGE AND RESEARCH
INSTITUTE, COIMBATORE.

The several views that are now held regarding the so-called 'Spike' disease in Sandal have been admirably summed up by Mr. R. S. Hole, Forest Botanist at Dehra Dun, in the March number of the *Indian Forester* (9). The most recent of these are the views of Dr. L. C. Coleman that the "disease is in all probability produced by a virus" and of Mr. Hole himself, that the "disease is a result of the prolonged action of various injurious factors, such as fire, damage to hosts, suppression, and damage by twig killing fungi." It is not the purpose of this article to open any controversy regarding either of these views or of others which are still gaining currency but to dwell on certain aspects of the subject which points to an immediate solution of the

problem if they do not actually solve it. I agree in the main with Mr. Hole's 'unbalanced circulation of sap theory' (9), a simple enunciation of which was made earlier by Mr. T. A. Whitehead in 1916 (20), but I entirely differ from him regarding the possible causes which bring about the formation of the spike. I am convinced that we are here dealing not with any disease but with an atrophied condition of the plant due to serious disturbances in the osmotic equilibrium of the parasite and caused by connection with unfavourable hosts.

2. It is little realized to what a great extent the phenomenon of spike in Sandal is bound up with its parasitic habit. In Sandal we have an unique parasite not of the worthless and destructive Orobanche or Cuscuta types which have descended to the meanest level of parasitism but a stately plant still nearer the autophytic mode of life and can at least in the earlier stages behave like a true independent plant. In one case our endeavour is how best to suppress the degenerate parasites in order to protect the crops while in the other the parasite itself is the crop and its further degeneracy has to be completely prevented so as to keep it as nearly autophytic as possible. The meaning of this will be made clear below.

3. From the statements of numerous observers we know that parasitism in Sandal has been carried to a varying degree. In the absence of hosts, plants have been known to lead an autophytic existence though, of course, the majority of them recklessly attack the roots of any hosts they come across so much so that the number of hosts till now recorded is very near 150 belonging to about 120 genera and 50 natural orders and it is probable that many more will be known in future (18). There is no reason to suppose that this indiscriminate attack of hosts which results in the partial degradation of the plant will ever cease when it has so seriously begun unless it is carefully guarded from its dependant tendency. One would wish that we had more precise knowledge as to the extent to which parasitism has gone on in this plant and if it could be ascertained that there are at least certain types which keep on to an autophytic mode

of life even without their roots becoming self parasitic it will be of the greatest importance to preserve them from extinction for the future economy of this plant, another point of considerable importance that requires pressing investigation is the effect of several hosts in producing the spike in the parasite. The work of Mr. Tireman (19) and others has shown that a greater incidence of the spike is reached wherever the Sandal is associated with Lantana as host. There are evidently numerous other hosts which produce a similar effect as Lantana and this should account for the appearance of spike in regions without Lantana. A statement of such hosts in the ascending or descending order of their deleterious effect based on observation will provide material for investigation on the lines referred to in this paper. So far as the observation of many people goes Lantana appears to be the most undesirable host.

4. One of the essential conditions of parasitism is that the parasite should possess an osmotic pressure higher than that of the host, that is, the sap of the tissue in the root of the parasite Santalaum, for instance, should be of higher concentration than that of the sap in the root of its host. Three situations are rendered possible when the roots of a host and parasite are brought into contact so as to behave as a "nutritive couple." Firstly, the pressure of the sap in the tissue of the haustorium may be higher than in the host root in which case the parasite obtains a supply of water and salts from the host. Secondly, the sap pressure of the two may be identical and a diffusion of the sap may take place through the haustoria owing to the force created in the ascent of the sap as a whole. This is what will happen when the plant is self parasitic though even in this case there is the possibility that, of the two roots, one may possess a higher osmotic pressure than the other. Thirdly, the host root may have a higher osmotic pressure than the root of the parasite and this may result in a reverse current being set up owing to a negative or abnormal osmosis in the root of the parasite. This latter contingency, however, will never arise as the haustoria are endowed with a peculiar power of accommodation by

which "the encounter of the absorbing organs with a superior concentration of solution is followed by an automatic increase in the osmotic activity of the cell sap in the absorbent cells, which might or might not be participated in by the whole body," "it being obvious that any plant (host) would soon free itself from a dependant (parasite) which did not follow it in its extreme concentration, thus entailing, of course, the power of automatic adjustment in the osmotic activity of the dependant" (16). From a study of numerous artificial parasites MacDougal and Cannon (16) came to the conclusion that no species can maintain itself on a host with superior osmotic power. The parasitic relationship of several mistletoes and their hosts were studied by Harris and Lawrence (8) and they found that the osmotic pressure of the parasite was generally higher than that of the host. In a few cases where it is not so the host "is assumed to supply more than sufficient water to meet its own needs, the parasite securing water from the transpiration stream of the hosts." From this it is obvious that the part played by osmotic pressure in the relation of the Sandal to its host affords a valuable clue to the discussion on the healthy or spiked nature of the plant and further investigations will be necessary on purely physiological lines in order to determine the osmotic pressure of the several hosts now known to be attacked and arrive at definite conclusions regarding 'good' and 'bad' hosts.

5. The special mechanism which regulates the osmotic pressure in the haustorium appears to reside in the starch grains contained in the inner cortex of the haustorium and bordering on the water-containing tracheids.* When the osmotic pressure of the cell sap in the root or the host is high it will require a relatively higher pressure in the cells of the haustorium also to absorb the liquid and considering that the absorptive cells owe their power of absorption to the sugar solution contained in them, it will be easy to understand what a large amount of this substance (non-electrolytes) will be required to absorb the nutrient solution of the

* Starch is characteristic of the haustoria in numerous other parasites and so its presence in the Sandal haustorium has nothing to do with the spike (21).

host which will contain mostly inorganic salts (electrolytes) dissolved in the cell sap. The hydrolysis of starch for the purpose of maintaining the necessary osmotic pressure is evidently effected by the water contained in the haustorial tracheids, its total disappearance indicating the maximum effort of the haustorium to obtain water from the host. Dr. Barber (2) was rightly of opinion that the absence of contents indicated failure of the haustoria to penetrate the host or its moribund or decayed state. Dr. Coleman (5) noticed starch in a healthy Sandal-Lantana haustorium but not in the self-parasitised haustorium of a spiked Sandal. To the mass of haustorial tracheids in the 'nucleus' Kusano (11) attributed the function of regulating the water-supply for the parasite as he thought that they are too conspicuous to be regarded as a mere continuation of the other tracheids. Arguing from a different standpoint he came to the conclusion that the "development of the tracheidal element in the haustorium may be connected with the mutual relation of the parasite and the host with particular regard to the amount of water which they require." That the function of the 'Speichertracheiden' is really to regulate the osmotic pressure in the absorbing cells of the haustorium by supplying water for the dissolution of starch as stated above does not seem to admit of any doubt. Kusano argues still further as follows, and as his view has a most important bearing on the matter I have to quote them at length here. It applies to Siphonostegia and Santalaceæ as the haustoria of both are said to resemble each other very closely. "Since the transpiring organ, the leaf, may have different structure in the host and parasite, it is obvious that the demand for water is not equal in the two, notwithstanding that it has to be supplied by the host root alone. From the anatomical characters of the leaves and using 'cobalt test,' we may be sure that the transpiration, for instance, in Buckleya surpasses that in any of its hosts—conifers and some foliage trees, and its variation during day and night, and under different conditions of environment, may be greater than in its host,* or

* This is exactly what has been proved for some of the Javanese Loranthaceæ parasitic on *Mangifera indica* and *Psidium Guyava* (22).

the supply of water by the host root may not necessarily accompany its loss by the parasite. It may therefore occur that, under a condition which promotes transpiration in the parasite, the amount of water necessary to replace it may not be supplied by the host. At any rate it is certain that the demand and supply of water in the parasite is not always uniform under different conditions of environment." "Therefore it is highly probable that in both parasites (Buckleya and Siphonostegia) the massive tracheids in the nucleus of the haustoria may act as a reservoir of water, serving either to supply or retain it according to circumstances; in short they act as the 'regulator' of water supply for the parasites." MacDougal and Cannon also are of opinion that the specialized tracheids carry a large 'water balance' which is an accompaniment and a condition of parasitism (16).

6. If the above views are recognized the explanation for the actual cause of the spike is an easy matter. The several hosts associated with Sandal are herbs like Acalypha indica, shrubs like Lantana and trees like *Thespesia populnea.* The herbs and shrubs are very short-lived and the life of the latter probably extends to a few years which is nothing in comparison with that of the host which, according to the computation of McCartny, reaches its maturity between 50 and 60 years (14). Taking Lantana as typical of the shrubby hosts we may easily understand what will happen to a long lived dependant like Sandal. If the host and parasite start life together the parasite will in some measure sustain itself on the nutritive materials (by no means liberal) supplied by the host so long as the latter is alive but an earlier death of the host should of course ensue and the result will be the decay of its root system. The haustoria which so far have lived upon the host should necessarily suffer starvation and ultimate death. MacDougal and Cannon also are of the view that decadence of the haustoria should frequently be traced to an insufficient supply of water (16). The abrupt termination of the roots of Sandal by means of haustoria owing to the atrophy of the part beyond the place of attachment in the earlier stages prevents the further development of the root in search of new

host roots and as has been repeatedly observed by numerous investigators the more the development of haustoria the less the formation of root hairs and as absorption by the haustorial organs is checked first by the depletion of the host roots and secondly, by their gradual death, the plant becomes subject to a diminished water-supply which is not sudden but 'prolonged' for a considerable period of time. It is true that more hosts (Lantana) are continuously formed beneath but it cannot certainly be expected that more haustoria will be as rapidly formed to replace those that have been incapacitated by the death of the previous hosts. The success of the young Sandal plantations in the earlier days of the 'Lantana invasion' should no doubt be explained with reference to the above facts. The Sandal-cum-Lantana relation may well be compared to a noble millionaire who had seen better days depending for his existence on a poor but generous host who gives all he has but nothing more. Host and guest fall together.

7. Shrubby or herbaceous hosts also affect the plant in another way. The osmotic pressure in their roots may be considerably lower than in the case of large trees and the quantity of water supplied by them will be extremely insufficient for a mighty host like Sandal. It is for this reason that many of the hosts certified to be 'good' by Forest Officers are arboreal and should necessarily possess a higher osmotic pressure. *Zizyphus sp.*, *Acacia sp*, *Canthium*, *Capparis*, *Casuarina*, etc., are pronounced xerophytes and it is well known from the works of Fitting, Livingston and others (7) that such plants are characterized by a high pressure indeed. Nothing can be more interesting in this connection than the observation recorded by Mr. A. W. Lushington (13) that Sandal flourishes particularly well when associated with oil-containing species.

8. The gradually diminishing supply of water which occur when the Sandal is associated with inferior hosts like Lantana brings about serious changes in the aerial portion of the plant resulting in the stunted growth of the leaves known as the "spike." The cells of the leaf are no longer capable of maintaining their turgidity and consequently the further growth of the leaf by the

division of the cells is reduced to the minimum. Dr. Butler's (4) observation that the number of stomata in an unit area is greater in a spiked leaf than in a normal one was perhaps confined to leaves of the same size, *viz.*, a young normal and an old spiked leaf.

Reduction of water-supply also affects in other ways, *e.g.* (1) the nutrient salts brought to the leaf decrease in quantity, (2) the photosynthetic activity is also lessened and with it the production of osmotically active substances. But the continuous loss of water from the leaf brings about the concentration of these substances and this results in a rapid increase of the osmotic pressure which continues for some time till the leaves reach the final stage of wilting and inevitably succumb to the catastrophe. This high osmotic pressure is also manifested in the much larger size of the epidermal and mesophyll cells in spiked leaves leading to their more rapid maturity (3). The translocation of carbohydrates from the leaves to the other parts of the plant is also checked to a considerable degree as this is a function of the transpiration current which is extremely slow. This should account for the accumulation of starch in leaves and twigs.

9. Though the leaf is well adapted for reducing the loss of water by transpiration because of the absence of large air-chambers in the mesophyll, there is nevertheless some loss of water through stomata probably supplemented to some extent by cuticular transpiration as well. The effect of such a loss which is not balanced by an adequate supply will be to reduce the water content of the leaf. Iljin (10) has shown that with a greater supply of water the starch in the guard cells of the stomata disappears, being probably converted into sugar which is osmotically active and the guard cells become turgid and increase the stomatal opening. When the water content is reduced either by less supply or by greater transpiration the guard cells lose their turgidity, the stomata become narrow and starch reappears again. As Iljin sometimes found open stomata even in wilted plants the appearance of starch does not so much indicate the closure of the stomata as a diminution of the water content in the guard cells and in the leaf as a whole. Iljin came to the following conclusion: "The change in the total

water content in a plant acts as a stimulating factor which brings about the commencement of enzymic activity in the guard cells whereby the starch is changed or converted from an insoluble to a soluble state (most probably sugar)." This ingenious method of testing the water content of the leaf by means of the starch in the guard cells of the stomata will be most valuable in researches of a similar nature. I am unfortunately not situated in a Sandal tract and the only material I could make use of are two healthy trees in the Botanical Garden of the Agricultural College and some spirit specimens of spiked twigs kindly spared to me by the Curator of the Gass Forest Museum, Coimbatore. The examination of the material showed the utter collapse of the stomata in the spiked leaves and a great abundance of starch in the epidermal cells which undoubtedly points to the only conclusion, *viz.*, the insufficieney or complete stoppage of water in the case of the spiked plant. The healthy twig was collected at 9-30 A.M. on a somewhat cloudy day (7-12-1919) and I have no knowledge regarding the time and hour of collection of the spiked specimen. As the present season is far from favourable for a detailed study on this point specimens will be collected next summer if opportunity occurs and more exact data will be collected regarding the starch content of the stomata and cells at different times during the day so as to contrast the normal and spiked specimens. It is enough to state here that in spite of the error due to the difference in the time and place of collection the result of the starch test is sufficiently clear to justify the above conclusions.

10. The deposition of starch in increased quantities in the spiked leaves has been the subject of some speculation among investigators. But in the light of our recent knowledge we are in a position to explain the accumulation as due to the reversible action of enzymes. According to Barnes (1910) (3) "the action of a number of enzymes is known to be reversible, *i.e.*, they not only, under certain conditions, hasten the otherwise imperceptible decomposition of a particular substance into two or more simpler compounds, but also, under

other conditions, accelerate the combination of the simpler substances into the more complex one. Indeed, it seems likely that the constructive action of enzymes may soon be shown to be as important as the destructive. This action would be of the greatest importance in the making of complex foods from simpler ones, such as the formation of starch from glucose, of cane sugar from glucose and fructose, of proteins from amido-compounds, etc. But the knowledge of this constructive action is yet very scanty." Lundegardh (1914) quoted by Atkins (1) was of opinion that the system starch sugar is not a simple reversible action governed by the laws of mass action but a later author (1918) (17) holds a quite opposite view and comes to the following conclusions :—

(*i*) "Enzymes as catalysts should accelerate the reaction in both directions, *i.e.*, be capable of synthesising the compounds which they hydrolyse.

(*ii*) The demonstration of the synthetical action of enzymes is difficult as the equilibrium point is generally so near the point of complete hydrolysis.

(*iii*) The effect of a catalyst upon reversible reactions, as it effects the reaction to the same degree from both sides is not to alter the position of equilibrium of the reaction.

(*iv*) The final position in the case of enzymes is usually reached when the products of hydrolysis make up over 90 and sometimes nearly 100 per cent of the mixture. This is on account of the large proportion of water present.

It thus appears probable that the conversion of starch into sugar and *vice versâ* is largely due to enzymes whose activity depends on the greater or less supply of water. For beyond a certain concentration the further hydrolysis of starch is prevented and the osmotic pressure is thus kept within limits just as the synthesis of starch itself is limited by osmotic pressure in leaves.

11. This view is confirmed by another piece of evidence contained in Dr. Coleman's work, *viz.*, the diastatic activity of the

normal and spiked leaves during the day (5). The temperature variations for the day have not been furnished by Dr. Coleman but as they are generally uniform at any rate in S. India I take it the minimum and maximum are at about 6 A.M. and 3 P.M. respectively as it is the case in Coimbatore. The spiked specimens used by him were from one in an initial stage and the graphic representation of the diastatic activity arrived at after so much laborious investigation really shows more than the author appears to have intended to convey, for, in addition to the diastatic activity it gives us a clue as to (i) the variation in water content, (ii) the variation in transpiration, and (iii) the osmotic activity of the leaf tissue during the day based on the first two conditions. With wonderful precision the diastatic activity of both normal and spiked leaves coincide at 6 A.M. and 3 P.M. and these stand widest apart at 12 P.M. The diastatic activity being due to the presence of water we can well try to explain how the latter is affected by transpiration. The loss of water from leaves is at a minimum just before sunrise. The slow rise in temperature after 6 A.M. increases transpiration which exceeds the supply of water and the osmotic pressure reaches its highest point at 12 A.M. when evidently the maximum of relative transpiration is reached though the maximum evaporative power of the air is reached later on in the day, *e.g.*, at 3 P.M. Livingston (12) arrived at this result from a study of other instances and he interpreted this to mean that some *internal changes* take place in the leaves even while the evaporating power of the air still continues to increase (12 to 3 P.M. and after). The internal change in the case of the Sandal in the earlier stages of the spike from what has been explained in the previous pages appears to be an increase in the concentration of the osmotically active substance (sugar) first by the transpiration of water in the first six hours and secondly by the production of this substance in photo-synthesis which exerts a high osmotic pressure and succeeds in securing a greater supply of water helped at the same time by the lessening of transpiration by means of stomatal regulation. The osmotic pressure, however, appears to

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regain its level along with the rise of the curve which denotes a rise in the water content of the leaf. The subsequent sloping of the curve indicates an increased rate of transpiration when the regulating factors disappear and the highest osmotic level is attained at 12 P.M. coinciding with the lowest point of diastatic activity. The second rise from 12 P.M. to 6 A.M. is due to increased absorption and prevention of loss of water owing to the saturation of the atmosphere. This explanation inconsistent as it may seem nevertheless appears to be highly probable. Livingston (12) who considered the problem of water loss by transpiration expressed on this point in very happy terms as follows :—"The supposition has the appearance of a paradox since the acceleration of a process (water loss) is postulated as causing the retardation of the same process, but such phenomena are not infrequent when disturbances in the equilibrium of a system are dealt with and the suggestion seems worthy of careful theoretical and experimental considerations." Both theoretical and practical considerations appear to me to provide sufficient justification for adopting the above views. As regards the later stages of the spike the osmotic pressure seems to be completely reduced owing to the disappearance of all organic substances and this is to some extent indicated by the low ash content of the spiked leaf as compared with the normal one (5). In a healthy leaf, however, the disturbance in the equilibrium is not so great and the variations in the curve are proportionately little as the loss by transpiration is nearly met by an equal supply of water.

12. The ultimate effect of the cutting off of water supply in the plant which results in the increased deposition of starch in the leaves and twigs may well be likened to the permanent weakening or stoppage of water in a navigation system. The commodities (starch) will be stranded at different centres owing to difficulty of transport and goods will accumulate at the chief stations till these could receive them no longer. The manufacture of the essential articles will therefore cease and in the absence of other means of transport the machinery involved will go to utter ruins. Without pressing the analogy too far we may say that

the leaves eventually die of water starvation as the tissues fail to perform their functions in the absence of water. The exact appearance and symptoms of the spiked twigs have been given by previous writers and it is needless to describe them here again.

13. I have thus tried to adduce sufficient reasons for the explanation of the spike on purely physiological grounds I am aware that the arguments in favour of my view are perhaps erroneous in some respects or that the data are not sufficiently clear to justify many of my conclusions. With our limited and superficial knowledge concerning many of the vital phenomena of plant life we are necessarily forced too often to form only a mental picture, imperfect though it may be, of what may probably take place inside the plant. It will be conceded that the importance of the subject is exceeded only by its difficulty and there are absolutely no data physiological or ecological regarding the vital activities of any plants under Indian conditions which could safely be applied to the present problem. The inferences are largely drawn from the authoritative opinions of foreign workers and how far I am justified in this must be left to the judgment of others who have scientifically investigated the subject.

14. *Is it infectious?* The spike is not infectious for it is not a disease. Its apparently infectious nature is perhaps due to the fact that the majority of the plants are similarly circumstanced in a given area. Much of the investigation in the past has been wrongly based on the assumption that it is a specific disease and it was unknown whether it arose in the root or in the aerial organs. Unfortunately the belief still prevails that the 'disease' is airborne being carried by insects and other agencies. It seems to me that such crude views should at once be dispelled so as to save needless labour and expenditure in unnecessary directions and to direct our energies towards the investigation of the plant in its physiological aspects referred to above concerning, for instance, the suitability of the several hosts, the climatic factors determining the distribution of Sandal, the dependence of the oil-yielding capacity of the plant on climatic, environmental and other conditions, etc. The

infection theory of Dr. Coleman has been sufficiently criticized by Mr. Hole (9) and it is unnecessary for me to take up the question here But there appears to be one error—and that serious—in the experiments conducted by him which vitiates the result. I refer to the removal of twigs and branches in the process of grafting which deprives the plant completely of its foliage and thereby an important factor concerned in the ascent of sap, *viz.*, osmotic pressure of leaves fails to operate (6). In such cases the water supply will undoubtedly diminish and cause a poor development of leaves. The formation of healthy leaves near the bottom is clearly a sign of satisfactory supply at this point. Further, it must be recognized that grafting is itself a 'phase of parasitism' and the passage of water between stock and scion will in any case be interfered with.

15. *Prevention and remedy.*—The fact that the spike is not a disease makes it peculiarly difficult to suggest measures remedial or preventive. The wrong notion of a fancied disease has been largely responsible for the ruthless removal of hundreds of thousands of trees during the past many years though such removal would have also been necessitated otherwise because of the inability of the plant to recover from a spiked condition. But a few effectual measures for controlling the phenomenon suggested themselves to me during the course of this paper and they are briefly stated below :—

(*i*) *Hosts.*—It will be evident from the foregoing account that the hosts of the Sandal should be trees and with an osmotic pressure somewhat but not very much below that of the Sandal and they should be of greater duration of life. As MacDougal and Cannon (16) state "a certain coincidence of habit is prerequisite as a slow-growing perennial could not flourish or survive if attached to the body of an annual." Experience of Forest Officers has also shown that such hosts as *Acacia*, *Albizzia*, *Pongamia*, etc., are suitable and these should be associated with the Sandal in establishing new plantations. It seems quite possible that in this regard

evergreens will be superior to deciduous trees because of the low rate of transpiration in the latter when the leaves are shed. This is testified by the observations of Mr. Rama Rao (18) according to whom evergreens like *Thespesia populnea*, *Pithecolobium dulce*, *Psidium Guyava*. *Mimusops Elengi*, *Litsœa zeylanica*, *Streblus asper*, etc., are very satisfactory hosts. MacDougal and Cannon also arrived at the same conclusion from a study of the parasitic relationship of *Krameria* with *Parkinsonia microphylla* (16).

(*ii*) *Lantana.*—That the damage caused to the Sandal in important tracts has been greatly due to Lantana cannot be denied to the least extent. The existence of spike in areas without Lantana is as shown in an earlier portion of this paper due to similar shrubby or otherwise unfavourable hosts. Lantana is, however, by far the worst of these because of its extremely quick growth and its smothering effect on other plants. The success with which this obnoxious weed has established itself in several parts of this country was a matter of serious concern to all and an entomological assistant was deputed to investigate on the possibility of eradicating or checking this weed by means of insect agencies. The result of the investigation will be awaited with interest. So far as the Sandal districts are concerned the pest may be handled in two ways. Firstly, its introduction in new Sandal areas must be viewed with serious alarm for there could be no worse plague to this valuable plant than Lantana and we would therefore welcome any legislation which would make it penal for anyone to introduce it for any purpose. Secondly, a good deal of caution is also necessary in dealing with this pest where it is already in existence in Sandal tracts. Its sudden and total eradication will obviously deprive the parasite of the little support it has. The destruction by fire should

on no account be recommended as it is death to the parasite. A periodical removal of the above ground portion will probably provide additional nutrition to the parasite but only for some time. Any method of keeping the shrub perennial where it already exists either by preventing seed formation or by partial and occasional cutting will not only keep the pest in check but will also help the Sandal in obtaining more nutrition. I am not unmindful of the difficulty of the task and the enormous expenditure that will be involved in suggestions which are more easily given than carried out. But such operations are necessary unless we despair of success and abandon the areas altogether in preference to others which are free from this pest. There is of course nothing to prevent the utilization of this weed for some useful purposes and according to recent opinion the shrub may be turned to good account as manure and good substitute for tea may also be derived from the leaves by proper treatment. The slow extermination of Lantana must be followed by the planting of quick growing trees like *Casuarina* though it must be remembered that the life even of this plant does not exceed 25 or 30 years. The planting of such trees applies only to those areas which are already overrun by Lantana though the symptoms of spike may not yet be visible in them. In short it may be taken as the general rule that in a parasitic crop like Sandal the tending of the host is of far greater importance than any amount of care that may be bestowed upon the parasite.

16. *Improvement.*—If Sandal is a crop there is no reason why it should not be improved on lines similar to those applied to other crops. The long age of the tree precludes the idea of hybridisation altogether but bearing the parasitic habit in mind our attention requires to be directed on one or two lines of work on the future of this crop. This is to keep the plant parasitic to

a very sparing degree. Cases of plants leading an autophytic mode of existence have been recorded from time to time, and though this may not be strictly correct it will be for the future economy of the plant that it should be kept as pure as possible and prevented from its exclusively dependant habit.* We do not know for certain whether the parasitism of Sandal is fixed "beyond repair" or whether there are chances of "possible regression." But as MacDougal (15) says the "evolutionary movement is generally towards increased dependency of the parasite, accompanied by accentuated and more complete atrophies. The view that such a movement may sometimes ultimately lead to extinction, although by a long and indistinct way seems also justifiable by inference, although such an end must not be assumed for all groups of parasites." A practicable line of work is to select seeds from healthy vigorous plants believed to be autophytic and to grow them in special plots attached to the reserved forests. To each Sandal zone may be attached a nursery of 'pure crop' and experimental work may be started in different centres to find out if the selected plants or seedlings manage to live for a longer period than has been till now recorded. Parasitism in plants is after all an acquired habit and in the case of Sandal it should be a comparatively recent one. The presence of root-hairs at least in the younger stages points to a separate absorbing system whose development has been found to be inversely proportional to the formation of haustoria. In raising nurseries a selection of such seedlings as bear plenty of root-hairs seems to be a point worthy of consideration and a detailed botanical study on this matter will be needed. It is hoped that such work as the above is not beyond the scope of practical forestry.

17. In conclusion I desire to state that no attempt has been made in this paper to consider the complex of various environmental conditions which may be partly responsible for the

* An examination of the specimens in the Madras Herbarium lead me to the belief that such autophytic types probably exist. If so, they may be identical with the *Santalum myrtifolium* regarded by Roxburgh as a distinct species and by De Candolle as a variety (23).

formation of spike. A consideration of such external factors will require a detailed knowledge of the field conditions of which I am ignorant. My aim here has chiefly been to point to certain evidences including considerations of literature (cited below) which I believe are quite decisive in support of the theory that the spike is caused by the insufficiency and ultimate stoppage of water supply to the plant owing to its peculiar relations with certain hosts.

18. Finally, I beg to add that in the preparation of this paper I am deeply indebted to M. R. Ry Rai Bahadur K. Rangachariar Avl., Government Lecturing and Systematic Botanist at the Agricultural College and Research Institute, Coimbatore, under whose knowledge and guidance I first learnt to appreciate the importance of physiological investigations

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ARTIFICIAL REGENERATION OF TEAK BY SOWING.

In March 1919, sanction was accorded to the revised Working Plan of the Mount Stuart forests of the South Coimbatore division of Madras, which was prepared by Mr. H. F. A. Wood.

The most important prescription of this Working Plan relates to the artificial regeneration of teak by direct sowing over compact areas annually, a prescription based on the results of experiments made by Mr. Wood himself during the years subsequent to 1915. As this method of forming teak woods by direct sowing is not one believed to be in common practice, the following details of the work done and the results so far obtained may be of interest.

The forests are situated on hilly ground with an average elevation of between about 1,800 feet and 2,500 feet. In normal years the rainfall is about 67 inches, both the South-West and North-East monsoons giving rain

An area of 25 acres was surveyed in July 1918. All timber considered saleable was felled and removed at once. The felling of bamboos and unsaleable timber was started in September and completed in December 1918, everything being clear felled.

The first burning was done on the 11th of February 1919 but the fire was a bad one, owing to the greenness of the material, Piling and reburning went on continuously up to March 15th and even then a number of half burnt logs were still on the area and these had to be dragged out by elephants.

On March 19th the area was completely clear and after division into 4 sections by 2 inspection paths cutting each other at right angles, sowing was begun on that date. Long Sterculia fibre ropes, with bamboo pegs let into the strands at 3 feet intervals, were used for laying out the area. Loosening of the earth for sowing was done by means of iron spuds with wooden handles some 3 feet long, made by the village backsmith. Sowing was done 3 feet × 3 feet and to start with 3 seeds were sown at each place.

During the month of March labour is extremely scarce in the forests in question and the first section of the area, which was finished after 4 days, was sown by the District Forest Officer, an Assistant Conservator, a Ranger, 3 Foresters, 4 Forest Guards, several peons, and the wives of the elephant mahouts.

It soon became apparent that the seed, which had been collected several months previously, was of very poor quality, much of it proving sterile when broken open. When this was noticed, 5 or 6 seeds instead of 3 were sown at each place and eventually the 1919 seed was scrapped entirely, and seed which was fortunately in stock from the previous year was used, the whole of the first section of the area being resown with this seed after the rest of the area was finished.

At the time of sowing, two small nursery beds were prepared and seed was sown in them broadcast with a view to the resulting seedlings being used later on to fill up gaps. This proved eventually to be a very necessary precaution.

The thunderstorms of May stimulated the growth of grass and weeds but very little teak germinated. Weeding, however, began on May 15th.

On the 2nd of June the Conservator and District Forest Officer visited the area and were most disappointed by the outlook. This disappointment became acute in July when the District Forest Officer reported to the Conservator that germination was very unsatisfactory. A dense mass of wiry grass about one foot high covered part of the area and in this there were practically no seedlings, whereas in other places seedlings which had come up very sporadically were thought to be abnormally small and weak and to be growing very slowly. In the nursery a certain number of seedlings had come up but did not look very healthy.

Up to July 9th, clearing, burning, sowing and weeding had already cost Rs. 29-5-0 per acre and the prospect was most gloomy. However, the following steps were taken early in July :—

(1) Where, as was often the case, a bunch of seedlings was coming up in one place, all but one were transplanted into blanks,

(2) Seedlings from the nursery were planted out into gaps. (3) Germinating seeds from fermenting heaps, which the Ranger—Mr. Nicholas—had put out and watered in various parts of the area, were sown each morning. Owing to this original idea of Mr. Nicholas, some of the worst grassy blanks are now practically fully stocked with fine plants. (4) As many hill women as were available were kept hard at work weeding systematically in different parts of the area.

In August much of the grass before its seed fell was cut with sickles and fed to the Government livestock. This cutting of grass for the cattle is a work which has to be done every year and the cost of doing it was therefore not charged against weeding, a procedure about the exact correctness of which the writer has his doubts!

Weeding went on steadily up to the end of the first week of October and by the end of that month the despondency of July had been replaced by a very firm optimism.

The photographs, which were taken 6½ months after sowing, give an idea of the appearance of the crop early in October. Except for a strip running near the middle, in which the plants were scattered and there were various blanks, the whole area was virtually fully stocked with fine plants which were all free of weeds. It was impossible to give a true average height for the plants as there was so much variation, but to say that the general impression at the end of October was of an area covered with seedlings 1 foot 6 inches to 2 feet high with many individual plants of 3 to 5 feet in height would not be incorrect. Moreover, the thinning out of bunches, which was continued by subordinates even after plants were too big to transplant, had resulted in each individual seedling having, for the time being, sufficient room to grow and develop. A little more weeding will be required before the end of December but much of this will be done by subordinates free of cost.

The expense of establishing the crop has been high, chiefly owing to the high cost of felling the heavy growth of bamboo and to the amount of piling and reburning which had to be done after

A corner in one of the densest patches—photo taken at a distance of 10 ft.

General view of the area 6½ months after sowing.

the first burn. The actual figures up to the end of October are given below :—

	Rs. a. p.	
Clearing and burning the area and sowing seed—	24 15 0	per acre.
Weeding " " "	10 14 5	"

It is necessary to note, however, that, as stated above, a good deal of grass cutting is not charged under weeding. Again, since July, rice has been sold to the coolies below cost price, the difference being borne by Government. Fortunately it has been possible to have practically the whole of the weeding done by women at a rate of 2½ annas per cooly per day. Had the work been done by men it would have cost very much more. The writer thinks it possible that the weeding has been almost unnecessarily thorough, but is convinced that the expense is fully justified by the moral effect of establishing a "mamool" of thorough weeding amongst the local labour force and subordinates.

Experience gained makes it possible to give the following summary of points requiring special attention in future years in this or similar localities :—(1) Early felling to allow time for drying before burning. Next year's area was clear felled by the middle of October 1919. (2) Very careful selection of seed before sowing. (3) Preparation and sowing of a small nursery at very low cost. (4) Having a few shallow pits dotted about the area in which seed is left to ferment, watering being done if necessary. (5) Cutting of grass with sickles *before* it seeds. (6) Where seedlings come up in bunches, transplanting of all but one into surrounding blanks whilst they are quite young. (7) Constant weeding as required, under responsible supervision. (8) Continuation of the thinning out of bunches of seedlings even after the plants are too big to transplant.

Finally it may be stated that the Working Plan, as printed, is being modified to the following extent so far as regeneration is concerned :—

(1) Regeneration is to be concentrated so that the woods formed each year will, as far as possible, form a compact block

(2) Artificial regeneration by sowing is not to be confined to teak, but pure woods of other species are also to be formed if possible. The intention is to have pure woods forming in the aggregate the following percentages :—

Teak	40 %
Rosewood	40 %
Pterocarpus marsupium, Lagrestrœmia parviflora, Xylia xylocarpa, Terminalia tomentosa, Terminalia paniculata, according to the result of experiments to be made	20 %

A. WIMBUSH,
I. F. S.

EXTRACTS.

THIN PLYWOOD USES.

[Although the tendencies towards the use of thinner box timber are not applicable to India to-day they give us a line for the future.—HON. ED.]

What is probably the thinnest plywood so far made is that which was made a while back, experimentally, by the Forest Products Laboratory at Madison, Wis., which was made from veneer as thin as 120 to the inch. This is an interesting product, for which there may be a field of possible uses. It is, however, much lighter than any work the average veneerman or wood-worker desires to undertake. It raises an interesting question of the possibilities of thin plywood.

There are really two lines of possibilities in thin plywood. One is that of developing uses of and a trade for very thin plywood, a field which has not heretofore been entered to any great extent. The other is the development of the idea of using timber plywood in the everyday work of furniture and cabinet making, that is, of reducing the thickness of stock being used.

In this connection it is well to bear in mind the history of the packing-box business, where primarily the wood used was ⅞ inch to 1 inch thick. In time this was reduced down to 7/8 and 3/8 inch by resawing and planing, and for quite a while this constituted the standard thickness in packing-box making.

Then came a demand from shippers for thinner stock, and it was this which brought into action the genius of E. C. Mershon to develop a band resaw which would resaw an inch board into three thicknesses where before but two had been made. Incidentally the band resaw of to-day owes much of its development to the fact that the box trade demanded lighter packages, which meant thinner lumber, and this, in turn, called for fine resaws so that these thin box shooks could be gotten from standard inch lumber with a minimum of waste.

Now, not only do we have the box trade as an example of how thickness has been trimmed down, but finally there was a

connection between box-making and the veneer industry out of which grew the wire-bound business, using single-ply veneer and a wide range of boxes in which thin three-ply veneer panels are used in lieu of the old solid panels. These are thinner so they carry less weight and at the same time, being built-up stock, they give more strength than was obtained formerly from thicker sawed lumber.

Applying the same idea to the furniture and cabinet trade, it points logically toward opportunities for timber saving and economy generally through developing the use of thinner plywood in cabinet work. This is an idea that will perhaps receive active attention during the present year, and out of it there will come new standards in thickness which will affect a saving in timber and increase the importance of thin built-up work.—

[*Veneers, Vol. XIV, No.* 6.]

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The Edinburgh University Court has appointed Mr. E. P. Stebbing, lecturer in forestry, to the recently instituted Chair of Forestry.

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VOLUME XLVI NUMBER 10

INDIAN FORESTER

OCTOBER, 1920.

SOME FURTHER KHEDDAH INCIDENTS.

BY A. J. W. MILROY, I.F.S.

A good herd was reported on February 4th, conveniently situated for driving to the Borbakra stockade. It being market day at Kulsi, the Borbakra men were warned to hurry up and complete their marketing, and some were despatched to drive the herd, while the others accompanied me to the stockade. The drive went splendidly, almost too well, as some of the elephants came on a long way ahead of the beaters and remained quietly not far from the stockade. We at the gate heard them, but some of the stops, supposing that the elephants were as far away as the shouts of the distant beaters, started a conversation, with the consequence that nothing would induce the elephants to come towards the stockade after the beaters had come up and the hole herd broke up the hill to the east. The Borbakra drivers are particularly skilful and were able to bring the elephants back, but the headman being drunk, everybody began

to shout orders and the herd again broke away. By this time it was pitch dark, so we returned to the village and were indulging in a little mutual recrimination when we heard sounds of elephants being driven. The headman then recollected that he had sent off five picked men in the dark to bring the herd back yet once more, and apparently they were doing so successfully. We had to scuttle to the stockade as fast as we could but it would have been impossible to do anything on such a dark night unless very thorough preparation had been previously made. Some of the herd did pass round the outside of the stockade, which was very much to the credit of the bold five. It had been agreed that there was to be no interference with the Borbakra men in the conduct of the operations, so the day's muddle presented a good opportunity for a little "chipping," the point being that the headman, famous for his strength, would undoubtedly hammer the souls out of the talkative stops as soon as he had recovered from the effects of the liquor. He had been badly let down by his own men the previous season. He went out on one occasion with a number of men to drive, leaving instructions that the stockade men were to be in their places day and night until he returned. At the end of the second day he had got a herd into position for driving and decided to push them on that night. He had a koonkie* with him on to which he climbed at nightfall, but the creature had little courage and bolted as soon as some of the females of the harassed herd were emboldened by the dark to charge back. The mahout was all right, but the headman had a gun in one hand and only one hand to hold on with, so that the first branch swept him off and he dislocated his wrist. Soon after this episode a shower of rain came on, but it was of only a few minutes' duration and the drive proceeded The elephants did not stand again and the whole herd of 16 were driven into the stockade, but the gatemen had gone home on account of the shower and the herd just turned round and came out again. It is said that those gatemen would sit through a second Deluge now.

* An elephant trained in the capture of wild ones.

Two uneventful catches followed, but the Conservator came out at the beginning of March in time for quite a little round of excitement. We were just coming to the end of a day's Improvement Felling marking when we saw a messenger approaching with unusual haste. He had gone out into the forest at the back of the rest-house in which we were staying, to find some plants we wanted, but had found instead a large herd of elephants which had crossed into Kamrup from the Khasia Hills. The elephants were keeping very quiet, as they had been driven in the Hills and did not want to attract attention, especially as there were some new-born calves amongst them. Our men went out at once to block the path back into the Hills and various other paths leading in undesirable directions, and they were successful despite heavy rain, as only three big animals broke away. The herd, estimated at 60, crossed the road near the rest-house soon after dark and travelled in the direction of the Sandubi stockade. We hung about next morning until information reached us that the herd had crossed a certain corner of Sandubi Bil and driving would begin, and then we proceeded by boat across the bil to the stockade. The Conservator and I occupied a large machan near the gate, it being our rôle to close the gate at the right moment and to shoot any big tusker, which could not be kept in by other means. As the night promised to be dark, we were not exactly confident about our ability to carry out these two important duties properly. The drive was exceedingly slow and it was just getting dark when a bamboo breaking on the hillside above us gave warning of the approach of the elephants; soon afterwards we heard sounds of the driving party and there was a great smashing of jungle all round us but no elephants entered the stockade, and it was obvious from the sounds that the men were unable to press the herd properly, and quite a number of elephants passed outside the stockade feeding and munching perfectly peacefully. In the course of time everything became quiet, and after a heavy shower of rain men came with torches about 2 A.M. to say that the drive had failed. We had had nothing to eat since chota haziri, due to my failing to make any arrangements:

I was thoroughly miserable at the time from fever and large doses of quinine, and had omitted to provide for the Conservator's healthy appetite. However, he was not reproachful, and crossing to an island we had a meal at 3 in the morning, consisting of rice and potatoes boiled in a green bamboo. Thereafter we slept until a reasonable hour, returned for a bath and a meal at the rest-house, and again came back to the stockade in case the men could manage to bring the herd back. They failed to do so as the elephants broke right away, and as they had gone in the direction of other stockades we sent off messengers to give warning and block certain paths. This drive really failed on account of a tusker, a run-away with the ends of his tusks sawn off, which kept charging the men as did a female with a new-born calf. The men were afraid to close in after dark on account of these two animals, but we saw from the footprints that seven or eight elephants had actually entered the funnel the night before and had remained there grazing immediately beneath a machan, the occupant of which had only to clap his hands to drive the elephants in. I had previously taken the men in charge here to the stockade and showed them the machans where good men must be posted, but preferring their own method they had shoved up a raw youth at the last moment without telling him what to do, and he had just sat tight petrified with terror. They failed to get a catch at all at Sandubi and it served them right.

The Conservator motored me to Kulsi next day, and while he spent the night at the Tiyamara stockade, I was keeping watch on a road. The elephants had, however, been aggressive in the dark and it had been found impossible to drive them. We went back to Kulsi in the early morning for a meal and then the Conservator returned to the stockade and I to the road. Driving was already in progress in a direction parallel to the road and we could see how things were going by climbing trees, as the elephants were in a dried-up bil or swamp sparsely dotted with clumps of tree forest. Everything went all right for a time until we noticed that the herd was travelling very fast in front of the men, and suspecting that the elephants meant to try and cross

the road we had to put in a very fast run of about 1½ miles to stop them. I arrived at a path, which led across the road only in the nick of time to turn back two females and we learned afterwards that the rest of the herd, some way behind, were following these. There was every reason to suppose that these were two animals, which we had previously caught at Tiyamara and released after depriving them of their calves. I went on ahead after this with a number of men, whom I posted to block another path along which the elephants would try to break and then I joined the drivers. We kept the herd moving at a nice pace, slowing up a little to give the herd time to try and break away and be driven back. This manœuvre succeeded : we heard the elephants go off to our right, then the tok-tok of the stops and the rush-back of the animals. They were now bound for Tiyamara, so we began to hustle them as much as we could. They had to leave the swamp, ascend a steep ravine and drop down over the crest of the hill into the stockade, half-way down the hill on the other side.

Driving is usually done by two or three columns in "Line ahead" formation, the leaders of each column choosing a path through the jungle, and the men following one behind another. The advantages of this formation are that the men are kept together under their leaders, two or three paths, avoiding bad places such as cane-brakes, are all that are necessary, and the men can swing into line if the elephants show signs of making a stand or breaking back.

The elephants here did make a momentary stand and the column, to which I had attached myself, very nearly overshot the mark, but we saw our mistake in time, doubled back and swung into line facing the herd. We very soon reached the ravine and were jubilantly swarming up it when the unexpected happened, and the two aforementioned females suddenly turned and came thundering down at us, tails in the air, ears cocked and squealing like stuck pigs. The ravine is very steep, and rocky, and only contains isolated Sal trees and some bamboo clumps, affording light cover such as elephants hurry through as a rule. It is the

duty of the men with guns (there are usually two or three such) to discharge blank cartridges in the face of charging elephants, but the suddenness of this attack was too much for them and they scuttled away up the sides of the nullah. Impeded by ammunition boots and riding breeches, as I was, the few available seconds were hardly enough for me to crawl clear, but luckily the elephants were coming much too fast to stop and hunt any of us. I was horrified, however, to catch sight, out of the corner of my eye, of the men, who had been posted as stops and had joined in at the tail of the hunt, struggling along down below unconscious of what was coming upon them, but as the leading elephant came abreast of me I had time to let off both barrels of my 12-bore into the air over her back, causing her to swerve sufficiently to avoid contact with those below. This little incident held up the pursuit long enough to spoil the drive, and when we got to the top of the hill we looked down into an empty stockade with very bitter feelings. The Conservator told me that some elephants had come on ahead of the others and had broken through the funnel, as on a previously narrated occasion, and passed round the outside of the stockade. The balance had arrived at the top of the hill in time to hear the funnel stops trying to turn back the first lot and had gone away right along the crest. This herd was a fragment of the big one, which had been driven at Sandubi, and contained, so the Conservator told us, the tusker with the sawn tusks: he had not shown up at all in the drive nor caused us any bother. It was a pity he managed to get away, as he would have been a valuable take, and there is no doubt but that the whole herd would have been captured if there had been no interruption, such as occurred, to disorganise the driving at the last. After the drivers and the stockade men had had their say and properly reviled each other, I suggested that we should be up and doing, and make an attempt to catch those that had gone north past the stockade. They could only go half a mile to the bottom of the hill, because they would be held up there by a main road, which they would be afraid to cross in daylight. The best of the drivers then hurried away to get round

the elephants and hold the road, while we closed the south gate of the stockade and opened that on the north and arranged for the stops. I took what appeared to be the most important machan, a wretched affair within reach of an elephant, as it would have to be manned either by some one, who had no nerves, or by some one like myself, who would be afraid to seem afraid. The elephants might try and creep round the ends of the funnel, so we had to post men on the rocks well up the hillside. We were still in some confusion when an alarm arose that the elephants were coming. I got into my machan, but am not quite sure how; it had no ladder up to it, only a plain bamboo. The alarm was false, as the herd was trying to break out sideways parallel to the road, but our stops down the hill held them all right. We heard several attempts similarly frustrated and then, about 9 o'clock, there was an audible patter patter over the dry leaves in our direction. It was pitch dark but we could tell that the animals were coming fairly straight and were at any rate on the inside of my machan. I was sitting with my dao ready to knock against the tree at the proper moment, but some one on the ground outside of me got the funks on board and started a clatter. This would have been all right if there had been an answering noise from the opposite side of the funnel, but nothing was heard from there and the frightened elephants rushed down our side of the funnel, past the gate and up the other side. The steepness of the hill prevented them getting right away and they descended with a prodigious breaking of jungle and smashing of bamboos to the patch of high grass from which they had emerged, the shouting and fires on the road beyond preventing them from going any further. The explanation of the failure on the opposite side of the funnel was that the men stationed there had sneaked away home. The success of our operation depended entirely on absolute silence being preserved near the stockade, and I had had to be rude to the men opposite, who would keep on whispering in a most exasperating and unnecessary manner. They were offended at what I said, and, considering the whole scheme mad, they had quietly left without saying anything, perfectly convinced

in their own minds that no elephants would come near the stockade and so that their defection would not be noticed. The Conservator, I remember, sang out that he supposed it was all over, but I said we would persevere. Of course no other animal would be so absurdly stupid as to walk into a trap, which had been avoided in daylight, and which was so obviously still being watched by men, but the elephant is sublimely stupid and simple. There were two reasons which made me confident of success: one was that we had in front of us a small fraction of a larger herd and we knew that they were mostly small animals, and consequently devoid of courage or enterprise, and would make every effort to rejoin their herd, and the other was that they must be very thirsty after having been bucketed about on a hot day. They could not cross the road in the face of the fires, while we held the hills on either side of the stockade. We were now in for another long wait, the tedium being occasionally broken by sounds of our men below anticipating any move made by the elephants to try and outflank the position. I was lying back in my machan with my head resting on my topee when I unmistakably felt the curious thudding that one gets to associate with elephants. I could hear nothing while sitting up, but resting my head again on the topee I was convinced that the herd was cautiously coming our way, the animals evidently feeling for each step among the rocks. This continued for some time until at last there became audible a faint and stealthy crackling of the dry leaves on the ground. It is difficult to describe in words the almost painful excitement attached to such a situation. The inky blackness of the night under the tall trees could almost be felt, while the suspicion, it was hardly more, of a something stirring the leaves seemed to accentuate the absolute silence that reigned all round. There within 30 yards of us the mind could see the great beasts, ears acock and trunks raised to test the air, first one advancing and then the others closing up and halting, every muscle braced to swing round at the slightest hint of danger in front. Then a further advance by one bold spirit, backed up by the others as soon as they found that the bold one's few steps

forward had roused no hostile clamour from that extraordinary contraption in front, that lay athwart their path.

It had been arranged that no one was to stir until I first started tapping with my dao, and it was my business to judge from the sounds made by the animals when they were so close to the open door that my tapping would reach them as from their right rear. Premature action on my part would mean that the tapping would appear to the elephants to be on their right front or right side, and they would have interpreted the sound as an effort on the part of their enemies to drive them back, and back they would have gone full tilt. Delayed action, on the other hand, would allow the elephants to approach the gate so slowly that their trunks might locate the presence of the gateman or that they might see something about the stockade, which would convince them that any fate would be preferable to a further advance.

Fortunately everything prospered. I could hear that my first few gentle taps gave the herd some impetus towards the gate, and at once the men stationed further from the stockade than I, and those opposite took up their cue and raised whatever din seemed to each individual to be appropriate. I was straining to hear the welcome creak of the gate as it swung to, but there was nothing beyond a mighty rushing and cracking of dry sticks and for some terrible seconds I thought that the elephants were breaking through the funnel at the side of the gate and would get away. At last the gate began to groan, and, then, Bang! it was shut, blessed sound indeed. We had now to hasten to the stockade to light fires all round and repel the efforts of those caught, still an unascertained number, to break a way out. I was completely stuck in my machan until some obliging wight lit a torch and let me see how best I might scramble down, but we were very soon at the stockade, peering over to see what was inside. The catch was certainly a little disappointing, consisting of a female and three youngsters only, but it was some reward for a hard day. It was bad luck that we did not get another young tusker in, the man at the gate, a most level headed fellow, was able to see the glint

of a pair of tusks someway behind the other elephants and that was the reason of his delay in shutting the gate, and in fact, he waited until the female had nearly completed her tour of inspection inside the stockade before cutting the piece of cane, which held the door open. One of our men, hurrying along in the dark, ran into the tusker and had a lucky escape, as one of the tusks passed over his shoulder as he ducked and fell into a bush. We sent out koonkies in the early morning, but the tusker had swarmed up over the hill during the night and rejoined the main herd. My most estimable cook arrived from nowhere at 11-30 and the Conservator and I had dinner before turning in to sleep beside a fire near the stockade. I have vivid recollections of something approximating a thirst, as my last drink had been at noon, and I had spent a hot afternoon doing a lot of running, which was followed by not a little necessary vituperation,—always thirsty work. The koonkies had the youngsters noosed without any trouble soon after dawn, but the dhai on being set free caused some excitement by returning several times down the hill to the stockade in response to the bellowing of her calf. The Conservator had called my attention before the koonkies arrived to the odd appearance of one of the small elephants, and he certainly looked extraordinarily hunched up and sick. He was recognized, however, as an elephant, which we had caught the season before, but which had escaped from his owner, and his conscience must have been smiting him. As a matter of fact a solitary little chap like this has a bad time in a stockade as he belongs to no family party and comes in for many unkind kicks and pushes. It is interesting to record that this particular animal was deemed by the experts to be a muckna and not a tusker, and he had been bought by an ex-forest guard for the ridiculous sum of Rs. 500, a damaged tail helping to depreciate his value. He was certainly a tusker now, and the original owner was allowed to take him back after rewarding the drivers and noosers. Talking of tails, it may not be generally known that wild elephants have an unexplained habit of biting other elephants' tails off. I have seen a big muckna chasing his companions in misfortune

round the stockade and grabbing at their tails. He would catch the end of one in his trunk and then try to get it into his mouth, either by pulling the owner back or by himself putting on a spurt. He managed to nip off four before he was shot. Elephants are frequently taken with tails already damaged, so the practice is not confined to stockades, but I have never heard of tame elephants indulging in the pastime. Quite a number of tails get slightly injured by half-hearted attempts at biting: such tails will never grow a full brush again, but a little iodoform or similar application to keep the flies off is all that is needed to preserve the actual appendage intact. Native buyers are never content, however, with this, and they insist on putting tight splints even over what is a mere excoriation. The consequence is that the circulation is stopped and the end of the tail drops off. Our Forest Vet told me of a case where a man undertook to straighten out a kink in a newly captured elephant's tail. He tied some cane and sticks at the bend, saturated the bandage with kerosene and set fire to it! I must hasten to add that such cruelties can no longer be committed with impunity: the Cruelty to Animals Act has now been made applicable to the whole of Assam, and what the Chief Commissioner has named "The Elephants' Charter" is being drawn up to insure its provisions being obeyed in all elephant mahals.

The elephants were caught on March 6th and removed on March 7th, but that did not end the performance by any means. The men working this stockade were tryers and, being dissatisfied with the small catch, determined to make an effort to take the balance of the herd. It was a bold proposition seeing that the herd now contained three females, which had been caught here and deprived of their calves, but almost anything is possible with elephants, if one goes the right way about it.

I strolled out on March 8th to ask if there was any news, and met a man, who was able to tell me that the drivers had picked up the herd and had brought it a long way back towards the stockade. We had a great hustle to clean out and prepare the stockade but all was complete by the afternoon. I sent word to

the drivers that, if they were unable to press the elephants after nightfall, they were just to hold them and see if they would not come up to the stockade (but on the opposite side) as the others had done. The Conservator and I took stations at dusk. A single elephant came up to the gate after dark and then went back. Presently we heard more sounds and some elephants came very near to getting in, but one of the funnel men made a noise too soon and drove them back. After that only occasional single and very timid animals paid us a visit. We heard next morning from those, who could see better than we, that the elephants, which were frightened back, consisted of four big beasts only, and that all the youngsters were congregated some distance behind, so it is impossible to say what would have happened if the advance guard had entered at the gate. Those behind would probably have retreated from the noise made to drive on those in front. We were further told that one of the four was a very big elephant, and was recognized at dawn as being a muckna, and I am fairly certain that he and the three bereaved females constituted the advance guard. They were within a very few feet of being caught, and of course we would have retained the muckna and let the females go free again. It would have been an astonishing feat to catch the same elephants twice in the same stockade in the same season, but it is certainly a possible one. The situation was quite extraordinary as it was. Odd elephants were playing about at the crest of the hill, afraid to descend to the stockade in front of them and afraid to descend to the men behind them. Some of our machans were over the crest of the hill, so that the unconscious beasts were frequently rubbing against the very trees in which the men were sitting, but at no period did the young elephants come far enough forward for the men to try and drive them on. When dawn had fairly broken the elephants, disliking the skimpy cover in which they found themselves, descended into the ravine down which the two females had charged three days before, so I sent a messenger to the drivers to make one strong effort to drive the herd up. They were unsuccessful and the elephants

charged through them, but were headed and retained in a patch of dense jungle. They had been a night without water and we thought that, if we could only hold them for another day, they must walk into the stockade the following night. I had a machan built high up on a tree in the direct line of approach, and meant to occupy this myself, armed with a gun, so as to scare on the laggards at the right moment. The Conservator and I had scarcely taken up our respective positions in the evening when a note from the Ranger arrived simultaneously with the information that the herd had suddenly burst upon the men holding them in, and had broken away irretrievably. I could not help feeling quite glad, as they had had such a rotten time of it, first in the Khasia Hills and then in our mahal. I have forgotten to mention that the dear old thing we caught in the stockade lay down during the night and slept peacefully; she must have been dreadfully weary to do this, as usually only the smallest calves lie down in the stockade. Big elephants do not lie down for months after being trained, and it was four or five months even before two runaways, which we retained, felt sufficiently at ease to lie down at the dead of night.

The Ranger's note was interesting. He said that a female and two youngsters had been caught at Borbakra, and koonkies were urgently wanted, as a large gonesh (elephant with one tusk) had been taken but had broken out, and they were afraid that they might not be able to keep the dhai in during the night.

The Conservator and I hurried to Kulsi and had dinner while two koonkies and a sowari elephant were being made ready, and then we went off to Borbakra as fast as we could go. On the way, I recollect, we heard a strange call in the forest, which the mahouts ascribed to a lemur. We found that there had been rather a mess-up at Borbakra of what had promised to be a good drive. One of the funnels abuts, as was explained in a previous article, on to the paddy fields, and naturally elephants seldom break in this direction except at night, when they do not object to crossing the open land, so here the

Forest Ranger took up his position, disdaining the safety of a machan in a tree. The female and the two calves came along first and entered the stockade, but the gonesh, which was immediately behind them, did not like the look of things and followed up the funnel, meaning to break away along the paddy fields. The consequence was that he and the Ranger met face to face, the latter letting off the gun he had in his hand and bolting for dear life. The shot turned the gonesh back towards the gate, but also turned back the seven or eight elephants, which were approaching the gate too by this time. They went through the beaters and were lost, but the gonesh, not liking the noise made by the beaters in their efforts to stop the main part of the herd, had no alternative but to try and follow the first lot into the stockade, which appeared to be the only safe direction in which to proceed. His presence in the stockade, however, was not at all desired, as he was much too big a beast for us to tackle, so the gateman shut the door in his face to keep him out and the man opposite had time to tie it shut, but the gonesh had made up his mind and just barged the gate open and entered the stockade. The gate swung to of its own accord, which was lucky, because the men at the gate were so terrified at the sight of the big elephant that they bolted from their machans despite the fact that they were built on to two very large and solid Sal trees, which formed the gate-posts. The gonesh must certainly have been an enormous beast as everyone was agreed that the top of his head was visible from the ground outside. The stockade was now absolutely deserted and the gonesh began to try his strength at various points. The headman had a 12-bore and some of my lethal bullets, and it was decided to see what effect a bullet would have and that the Ranger should fire the shot, to give it an official imprimatur, as it were, in case of questions being asked afterwards. The Ranger crept up to the side of the stockade opposite to where the elephants happened to be, and thrust the muzzle through the palisade and aimed, so he says, at the head of the gonesh. Many of us must remember the case, cited by the Greek Grammar, of the gentleman who

"escaping his own notice, missed the mark and hit the boy" and a parallel incident occurred here, as it was the poor female which received the bullet. The effect on the gonesh was however electrical; he just turned round on hearing the shot, strode across the full length of the stockade and went straight through the palisade at the far end. It was a prodigious exhibition of strength that one would have liked to witness. It is possible that this particular animal had been in the wars in some other mahal, as he was reported to have a number of wounds on his body, and this supposition would account for his great fear of gunfire. To continue his story, he turned up at Kulsi next afternoon and was seen drinking in the river below the bungalow. I went out with a rifle in case the grass-cutters were molested while catching our hobbled elephants, but the gonesh bolted as soon as he heard the sound of men. A month or so later he was reported in a swamp not far from Kulsi. We were keeping a sharp look out at the time for the aforementioned tusker with the sawn tusks as we had planned to catch him by attracting him with our female elephants and then doping him with a tasteless preparation of opium, hidden in bundles of paddy, while we secured him with ropes, so all tracks of single elephants were followed up by those anxious to earn the reward promised for finding the tusker. Two days or so after the gonesh had been tracked up a very large wild tusker entered the swamp, and the following morning the gonesh was seen making for the hills with the blood pouring from a great hole in his chest. It is known that stags with one horn are often more than a match for stags with two horns, and I had often wondered if a gonesh had any advantage over a tusker, but in this case it seemed that two tusks were better than one.

The foolish old female did not make any attempt to follow through the hole in the wall, and this was speedily concealed with branches, but there is no knowing but that she might have found the weak place if there had been delay in bringing up the koonkies. The two koonkies took a long time over their job owing to the willingness of one of the calves, which repeatedly

escaped from the noose, and it was after midnight before we began the journey back to Kulsi.

The final catch of the season was at Ukhiam and consisted of 24 elephants, 10 of which were females and one a full-grown muckna (tuskless male). Everyone declared that there was no runaway amongst the females, but after watching the beasts for several hours I was able to spot rope marks on one, and she proved to be a trained animal. She must have been wild for eight years at least, judging by the age of the two calves with her, the younger of which was ready for weaning. Retaining this female added Rs. 1,500 to the value of the catch, that being the agreed-on price at which Government took over any elephants, so it was extremely careless of those interested in the sharing of the profits not to have detected this runaway themselves. The koonkies arrived in the afternoon and managed to take out and tie up seven elephants, working from 5-30 to 10 P.M., there being a splendid moon. The muckna was not a very formidable creature and our male koonkies took a delight in squashing him, but there was one young tusker, which was quite another proposition. He spent most of his time concealed in the middle of the herd, but every now and then he would sneak out and have a go at our koonkies, most of which were afraid to face him properly. He was cunning enough to disappear again amongst the females as soon as his raid was over, and so avoided the punishment which we were anxious to give him. On one occasion he caught our biggest koonkie unawares, at least the phandi was talking to some one and not paying attention, and getting a run on he knocked him over into the ditch: it looked as if there might be trouble, but, as always, the tusker at once retreated and did not follow up his advantage We were luckily able to throw a noose over him and secure him that night. The stockade being small, it was nearly filled by the wild elephants and koonkies combined, and there was not enough room for the tusker to put up an effective fight. He was noosed by a smallish muckna and by a tusker, both of which were mortally afraid of him. The dhurra (tying-up place) had been formed just outside the stockade, and

we had broken down a gap in one of the funnels to give access to the place. All the koonkies had to do was to drag the noosed elephant to the door, turn sharp to one side and there they were. The procession with this tusker was most undignified. The muckna koonkie having got his face to the door pulled his hardest to keep away from the wild tusker, while the tusker koonkie pulled his hardest in the opposite direction to keep away from those sharp tusks. It worked very well indeed, the muckna bellowed and pulled, the wild tusker tried rushes in both directions, but the tusker koonkie could only be made to back very gradually. Progress was slow, but they made for the door, the muckna pulled extra hard and dragged the other two out after him. Then the muckna was guided through the gap in the funnel, but the wild elephant made a rush in the direction of the forest and liberty, and was only restrained by our terrified tusker which was doing his best to get back into the stockade! Once through the gap a tree was soon reached and the tusker securely tethered, none the worse for having been violently pulled in opposite directions. We had decided to take him over on behalf of Government, and perhaps I may be excused a digression, if I recount here what happened to him. He was named "Kala Nag" on account of his character, and we found that he thoroughly deserved it; he was one of those rare elephants, which refuse to put out their full strength at first and so are extremely difficult to train. He used to behave in an exemplary manner after the first night or two when we were "mesmerizing" him, but he was only bidding his time, and as soon as the torches and men had left him he was ready to pounce upon any solitary individual who passed within his reach. It is well known that such elephants generally remain untrustworthy for a considerable time, because they escape the punishment which befalls those which struggle to get at the men during the "mesmerizing," and it was quite a long time before Kala Nag gave up chasing people. He received a bad cut on the sole of one of his forefeet at the time of being caught and this gave us a great deal of trouble as it was not easy to treat. The leg was mending well, when one

afternoon he was tempted by the Ranger and his children, who were standing rather close to the side of the road, and Kala Nag set off after them thinking he had a soft thing on hand. Luckily for the children the lid of a packing case was lying on the ground, butter side up, and the tusker put his bad foot on to the butter, which was nails in this instance, and went off with the lid firmly fastened to the sole of his foot. The mahout pulled him up quickly, but he had a dreadful leg for some months afterwards. The incident, however, cured him of his habit of going for people and he never attempted it again. When an elephant is sufficiently trained to go alone without a koonkie, we usually tie a long rope on to it, a man with a spear holding the end of the rope and walking ahead. The elephant at first cannot be restrained by the mahout, but rushes to catch the man in front: the latter whips round as soon as he feels the rope slacken and presents the point of the spear to the elephant's trunk, and a few days' discouragement of this sort is all that is necessary. Kala Nag, however, could not be tempted, after one collision with the spear, to fall into this trap again, and he followed like a lamb so long as he saw the spear in front. He managed to knock his mahout down during the first few days we had him, but failed to reach him with his tusks, and it was due to this exhibition of temper that everyone gave him a wide berth and so prevented other accidents from occurring. As a matter of fact he was nearer getting me than anyone else; I was peering from what should have been the safe side of a koonkie to see if Kala Nag had a chafe under his chin, and catching sight of me he lunged. The koonkie flinched instead of resisting the lunge and the tusks passing one each side of the koonkie's trunk the merest tip of one touched me on the jaw. It felt quite hard.

The leg healed and the elephant settled down very well, and gave every promise of being a very fine beast, when one day the grass-cutter came running in to say that he had been pitched off and that the tusker had bolted. Kala Nag was leading a procession of four new elephants on this morning, but becoming

mildly frightened at something he turned quickly round and ran back towards the elephant immediately behind him. She was a timid creature and thought he was attacking her, so she shook off her grass and bolted into the forest, followed by those behind her. The grass-cutter had dropped his goad when the elephant whipped round and failed to stop him, but the men on the other animals all witnessed that it was a very leisurely bolt and that the tusker had recovered from his fright. The grass-cutter threw himself off when they came to a patch of reeds as he thought he might be swept off,—miserable man. The departmental elephants were away bringing in grass and there was only a sick Civil Department animal in the pilkhana. The mahout took this and went after Kala Nag, and found him within a few paces of where the grass-cutter had dismounted. He shuffled away a little on being called and descended into a muddy stream to enjoy a bath, and could have been secured there, but the sick elephant, being extremely weak, refused to enter the mud. There was no cause for anxiety, so the mahout returned to Kulsi to take the first elephant that came in from the forest, Kala Nag sauntering, before they left him, into a thick patch of reeds. When the mahout returned, however, on another elephant, he found that a calamity had indeed occurred. A wild herd had been resting in the grass a little way on, and Kala Nag had gone in their direction. The wild elephants detecting the smell of man had sheered off, he after them, and eventually getting properly frightened they had legged it for the Hills in earnest, Kala Nag in hot pursuit. That was a piece of bad luck, as it was the end, so far as we were concerned, of our tusker.

To return to the stockade, we took out the remaining small elephants and the muckna next morning, and released the nine females. We carefully filled up the gap in the funnel to prevent them coming into the dhurra after their calves, but they did not go right away, and we knew that they were hanging about not very far off. It should be mentioned that one of the dhuis was the beast shot by the Ranger at Borbakra; her wound did not appear to be serious.

The elephants which we roped this morning, were marched straight away to my camp, some five or six miles off, and on another couple of miles to a selected patch of cool forest. I accompanied them as far as my camp, where I had my first meal for 30 hours, excepting some rice boiled in a bamboo at the dhurra the night before. The koonkies returned shortly and I went back with them to remove those still remaining tied up near the stockade. It was night before we were ready to start and the full moon was high up in the sky when we said good-bye to the stockade. Kala Nag was attached to our big muckna, on which I rode, and a smaller muckna. It was necessary to cross the arm of a swamp almost immediately after leaving the stockade, a nasty place, deep and very muddy. I had tried to improve the ghat leading out from the Bil, but it was a bit of a struggle for an elephant on account of the clinging nature of the mud. The idiot on the small muckna allowed his rope to slacken, when we were in the water, and just as the big muckna was kneeling on the firm ground and dragging his hind legs out of the mud, Kala Nag came into him full tilt. I must confess to thinking that we were bound to go over, but the muckna sat firm on the ground, bellowing as the tusks tickled him up. The other man then hauled back and allowed us to get up and continue the march. The incident made the big muckna a little nervous, and he was obviously keeping his distance from the tusker, but we gave him an innings when we reached the Kulsi river. We had halted for a drink, and Kala Nag thought it another good opportunity to have a dig at his big brother, so we set the latter on to him and it was the last occasion on which we had trouble in that line. It was a memorable sight, the river, the white sand and forest clad hills showing up almost as in daylight, while in the foreground was our string of elephants, plashing through the water. I do not say that I thought these thoughts as Mohun Muckna and Kala Nag struggled in the river, because it is as much as one can do to stick on an elephant swaying about and really fighting, but the scene is very vividly impressed on my mind as one of extraordinary beauty, excitement

and interest. I spent that night in my camp, instructing jemadar to fire a gun, if any wild males came round, annoying the dhurra. Sure enough I heard a bang early in the morning, then another bang, then bang bang. This sounded very serious so I rushed out with my ·577, meaning to hasten to the dhurra, but was astonished to hear, now that I was in the open, that the firing was from the opposite direction, where there was a village about a mile away. There could be no doubt about the meaning of the row, because we had left a small calf, sold to the headman, at the village and the mother was evidently trying to find her calf, supported by the remaining eight females. The noise went on for quite half an hour and we heard next day that the elephants had actually entered the village before being scared away. The disappointed nine then made a big circuit through the hills and arrived close to the dhurra just after daybreak, but were driven off by the koonkies after they had got half way across the river. Then, after I had gone out, they visited my camp and carried off a hobbled elephant, which was grazing close at hand. We were very anxious about her, as she had only been caught 12 months and this was her native place, in addition to which the hard ground and the number of elephants made tracking exceedingly difficult. Her own mahouts failed to pick her up, but five Garos got up to her in the evening, and as she would not allow herself to be caught drove her under a tree, on which one of their number had been posted and he jumped on to her back, a very plucky act, as most elephants in these circumstances would have shaken off anyone jumping on to them.

The nine remained in our Reserves for several months, and when last reported one of them had given birth to a new calf: how jealous the others must have been!

It took us two days to march all our captures to Kulsi, and we had to go very gently on account of the heat, but we had no casualties and the elephants sold for good prices at auction, averaging Rs. 1,280.

NOTE ON THE ARTIFICIAL RAISING OF BAMBOOS IN THE AKOLA DIVISION OF THE BERAR CIRCLE, C. P.

Introduction.

In this District natural growth of bamboos is insignificant. It is confined to only a few small areas. But nowhere are bamboos found in such quantities as to render systematic working feasible. The bamboos found are generally of a stunted habit and thin and, consequently, not of much commercial value. However, the available small numbers of mature and dry bamboos are occasionally allowed to be cut and removed at schedule rate of Rs. 2-8-0 per hundred by the local villagers under special permission of the Divisional Forest Officer.

For general consumption in the District bamboos are imported from the Melghat, Chanda and Balaghat forests and stocked by traders in their stalls at Akola, Akote, Karanja and Murtizapur.

Looking at the general physical features, the peculiar natural disposition of the forests and the climatic conditions of the District, one is not surprised to find the almost complete absence of natural growth of bamboos in it. But on careful examination of the forest areas, it is possible to find numerous localities in different parts of the District, particularly the wide flat and fairly wooded valleys in the long range of low hills and some isolated and fair-sized babul " bans " in the Murtizapur, Akote and Akola Taluqs, suitable for the artificial introduction of bamboos. Indeed, as the result of operations extending over the past 8 or 9 years it is pleasing to see that already a few such areas, in some of the low-lying and cool localities, have been stocked with promising young bamboo clumps and plants.

Physical description of the District.

Akola is a very dry district being situated between lat. 21° 16′ and 19° 51′ S. and long. 77° 44′ and 76° 38′ W., with an average rainfall of 26 inches, the rainy days not being more than 45 in the year. We have long spells of dry and hot weather (heat reaching 116° F. in May) being however redeemed

by occasional showers and hail-storms in the months of Jan. to April. This redeeming climatic feature is favourable generally to jungle growth and keeps alive the young tenacious bamboo plants put out in the forest. The chief forests of the Division which consist of stunted teak and miscellaneous scrub occupying an area of 185 square miles are confined to the range of low hills running east and west across the District, while in other parts are to be seen isolated babul "bans," widely scattered grass reserves and grazing grounds, the two latter aggregating to 128 square miles. The general elevation of the plain portion of the District is from 900 to 1,100 feet above sea-level, that of the tableland being 400 to 500 feet higher.

The Deccan trap covers the entire District, the underlying rock being hard grey basalt with softer varieties of trap. The soil resulting from the disintegration of these is generally light reddish brown clay which does not seem to be very fertile in the hilly forest tracts as can be judged from the general poor condition of tree growth which is comparatively better in the lower slopes of hills and in valleys.

Brief description of cultural operations carried out and results.

It would appear to have been the object of the Forest Department more than a score of years ago to introduce bamboos into the District. As the first step towards this object a small plantation of *Bambusa arundinacea* was created about the years 1884 and 1885 on the right bank of a perennial stream at Yeota 6 miles east of Karanja in the Murtizapur Taluq. The area then planted up with nursery raised seedlings was about 12 acres. The seed was sown in nursery beds 5 feet by 5 feet just after the first shower of the rains. As the seedlings were found to be too crowded in the seed beds 6 or 7 months after germination, they were picked out into freshly prepared beds and carefully tended for the rest of the year. When they were on an average from 1½ to 3 feet high they were transplanted into the selected area in pits 2 feet cube 10 feet apart, in lines also 10 feet apart at the rate of two plants in each pit. The pits were filled 1½ feet deep with loose earth and then

plants were put in, the remaining half a foot space being afterwards filled with earth again.

During the winter and dry weather the plants put out in the forest were watered regularly for two or three successive years or until they were sufficiently well established. For watering purpose two Government he-buffaloes with "pukhals" and two coolies were employed.

In the first year's operation about 6 acres of land were planted up in the manner described above and in the second another 6 or 7 acres were similarly treated. After this for nearly 10 years no planting operation was carried out. Then it was resumed, and now finally the total area that is under the artificially raised *Bambusa arundinacea* is nearly 25 acres.

As the area is within a stone's throw of the village of Yeota it was looked after by the Patel of the village who used to receive a small monthly remuneration for it. Besides this, two paid men were constantly on the watch and ward of the plantation. At present there are nearly 3,000 clumps in the whole area. The total cost of creation of the plantation was Rs. 399 and of upkeep Rs. 1,552. Mature and dry bamboos and windfalls are being collected departmentally every year since the clumps commenced to yield exploitable bamboos and are sold by public auction on the spot in assorted lots according to the length and thickness and quality of the bamboos. It would appear from the available records that the first cutting was made in the year 1902-03 and the total number of bamboos extracted up to 1917-18 was 65,046.

The total cost of the thinnings was Rs. 1,802. Sometimes when single, straight, long, well grown and well formed and selected bamboos are sold for special purposes under special permit an average price of Re. 1 is obtained for each bamboo.

The total revenue derived from this plantation up to the end of 1917-18 was Rs. 7,552.

Besides bamboos, teak and shisham plants were also raised in this area almost simultaneously and as the result we find now about two hundred well grown teak poles up to 2½ and 3 feet

in girth and 30 feet in height, some of them being lean a
and a few shisham poles of about the same dimensions.

Local tradition says that about the same time a Division Forest Officer, Mr. Taylor, introduced Sandal by sowing a few seeds in the area. As the result we have now numbers of young Sandal plants, saplings and trees subsequently reproduced from self-sown seeds and root-suckers. The age of the plantation may be roughly stated to be from 26 to 34 years.

It will be seen from the above that this bamboo plantation has been a genuine success and has amply repaid its initial expenditure and cost of subsequent upkeep, and afforded a stimulus for undertaking similar operations in other suitable localities of the District.

Nothing further was done, either in the way of extending the existing plantation or creating fresh ones in other localities from the year 1894 or so up to 1908 when the matter was taken up again. Small nurseries were first started in Yeota of the Murtizapur Range, and other places each measuring 1 chain square and fenced round with barbed wire fixed on to stout posts let into the ground at intervals of 10 to 12 feet. As an additional precaution against the ravages of small wild animals a thick barrier of thorns was put up on the outer side of the wire fencing.

Sites for nurseries were selected as far as possible in the vicinity of the area to be finally planted up with bamboos and where there was water close by. The nursery ground was thoroughly broken up by ploughing and cross-ploughing and beds measuring 5 feet by 5 feet were formed.

Bamboo seeds of *Dendrocalamus strictus* and *Bambusa arundinacea* obtained from different localities in and near the Central Provinces and a small quantity of *Bambusa burmanica* (*Thaikwa*), obtained from Burma in one of these years, were sown in the beginning of the rains and the resulting seedlings, which came up in a fortnight, were tended for one year and in the rains of the following year were put out in selected areas on alluvial soil in low-lying lands along the margins of ravines.

planting operation of this recent period was commenced year 1909. The young seedlings were at first transplanted this year into narrow cylindrical baskets made of *sindhi* leaf-stalks and each measuring 5" to 6" diameter and 9" deep. The plants were allowed to remain in these baskets in the nursery itself for a month. The baskets with the plants were afterwards transported by cart or on coolies to places where they were to be finally put out and planted bodily in previously prepared pits $1\frac{1}{2}' \times 1\frac{1}{2}' \times 1\frac{1}{2}'$, 6 feet apart and in lines also 6 to 7 feet apart. This was too close The clumps seem to be here suffering from want of growing space. The areas planted up were about 2 acres of Injha and an acre each of Chinchkheda and Pipaldara. For one season after this, they were watered and then were left to take care of themselves. Watering for two seasons would have been more beneficial to the plant, as previous experience has shown. Nearly 40 per cent. of them died and the rest got on well. Simpler and less expensive methods were adopted in subsequent years' operations.

New nurseries were started (the previous year's ones also being maintained) in a number of places each measuring 1 chain by 1 chain.

The cost of preparing a nursery and forming beds in it and fencing it with thickly packed thorns will be from Rs. 8 to Rs. 10.

The supply of bamboo seeds is received generally in February and March. They are immediately distributed to be sown thickly in two or three previously prepared beds in the nurseries. The beds are regularly watered and when the seeds germinate the resulting young plants are protected from the sun by means of thin grass "tattis" or leafy twigs put up, a foot or two above them, on supports. As soon as the young plants are 6 to 7 inches high they are pricked out in groups of 2 or 3 at a fair distance apart into fresh beds where they remain till the end of June or 1st week of July, being watered at regular intervals of two days. By this time they will have grown to be 18 to 24" high. They are then picked up carefully, without injury to their tender roots

with moist earth round them and then taken to the place where they are to be planted out. Pits measuring $1\frac{1}{2}' \times 1\frac{1}{2}' \times 1\frac{1}{2}'$ are made ready in the beginning of the rains when the ground is soft, at the rate of 200 to an acre, *i.e.*, at an equidistance of 15 feet and in lines also 15 feet apart. The little groups of plants lifted from the nursery beds are put one in each of these pits while it is drizzling, which are then filled up with loose earth to 3 or 4 inches higher than the ground surface sloping outwards from the stems, so as to drain off excessive water. A cooly earning from 5 to 6 annas a day can prepare from 40 to 50 pits and plant about 35 plants in a day.

In the rains the plants do not need watering but in winter and dry weather the earth at the base of the plants should be finely powdered and mounded up so that the roots may keep cool and the moisture may not evaporate The shrewd and practical Berar cultivator instinctively makes high conical mounds of earth at the bases of mango trees growing in his fields evidently with the same beneficial object. This is a familiar sight in the Berar fields. With this arrangement the plants may by watered once a week in the dry weather and twice a week in the hottest month.

Watering at intervals keeps the plants lively and vigorous As the planting operations extended to wider areas watering was found to be expensive and troublesome and not quite practicable So, in later years healthy and vigorous plants were put in the forest in the month of July thereby allowing them to have the full benefit of rain in the 1st season and were not subsequently watered but the earth at their bases was loosened, finely broken and raised into mounds round the stems. Although the growth of such plants is slower than that of the watered ones and some of the former may appear to have withered away above ground, still they have been observed to retain vitality enough to throw up new shoots in the following rains. Hundreds that we had counted as casualities to be filled up the following season were found to have revived.

It is essential to the well-being of the plants that grazing should be strictly forbidden in the plantations, which should also be fire-protected by a ring of burnt line round each, besides grass being cut and removed. Bamboos are observed to thrive well under light shade and in cool low-lying places in this District but not under heavy cover nor quite in the open.

An ideal bamboo plantation of recent creation is at Injha about 5 miles off Karanja in the Murtizapur Range and Taluq. Here are represented young as well as nicely developed clumps ranging in age from 1 to 8 years. The area occupied by them is a little over 25 acres. It is a narrow strip of land running along the margin of a perennial ravine and fairly well wooded with mango and miscellaneous trees. The older clumps are rather crowded having been planted 6 feet or 7 feet apart. The younger ones of recent planting are properly spaced being at least 15 feet apart on all sides. There is still ample scope for extending the plantation into the adjoining areas similarly situated.

Fig. No. 1 shows a fine group of 4 and 5 year old clumps in the Injha plantation.

The existing plantations in the Akola Division which have been formed between 1909 and 1917 cover 240 acres with an average of 132 clumps per acre, while the cost of creation and maintenance has been Rs. 11,556.

An interesting experiment was made in planting bamboos in four fields under cultivation, each being about 10 acres in extent, in the Forest village Umarwadi in the Balapur Range In one of them, not cultivated now, the young bamboo clumps which are now 3½ year old are getting on splendidly and in the others too which are under cultivation they are promising. These are younger in age being from 1½ to 2 years. These fields are not entirely treeless.

Fig. No. 2 shows a group of 3½ year old bamboo clumps in one of the Umarwadi fields near the village.

Some of the forest village lands may be gradually stocked in this manner with bamboos.

Fig. 1. Shows a fine group of 4 and 5 year old clumps in the Injha Plantation.

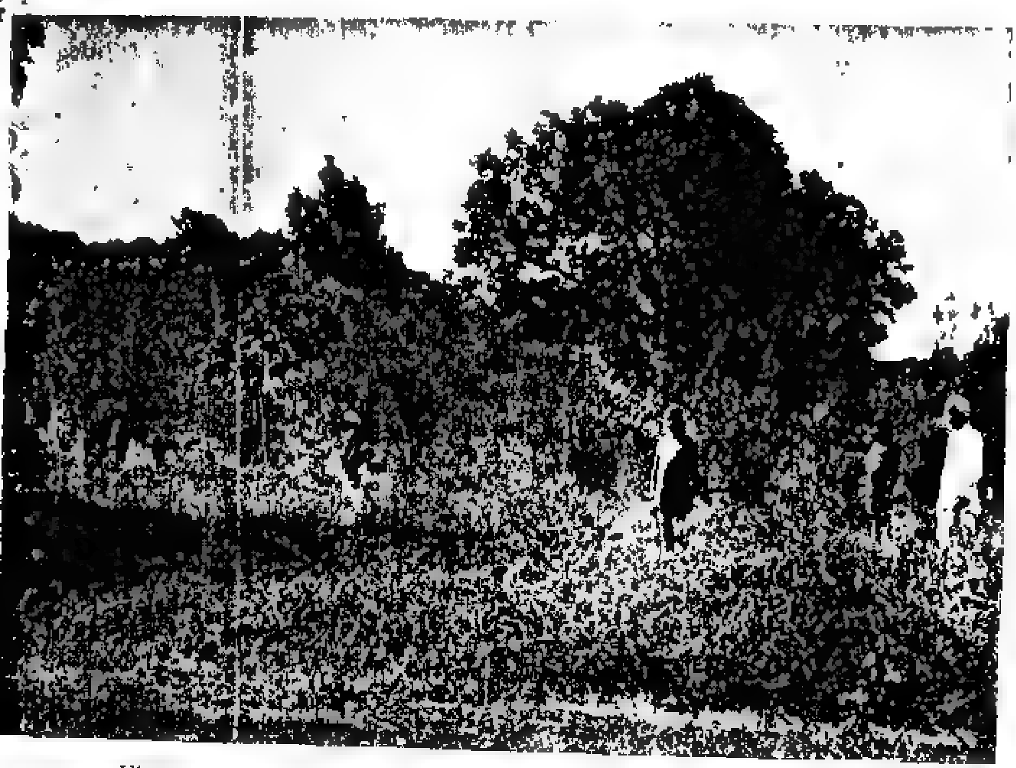

Fig. 2. Shows a fine group of $3\frac{1}{2}$ year old bamboo clumps in one of the Umarwadi fields near the village.

Photos by B. I. Shama Rao

Similar experiments carried on in the southern portion of the Karanja tank under the agri-sylvicultural method have not been so successful greatly due to the indifference of the lessees and partly to the irregular rainfall during the last two years.

B. I. SHAMA RAO,
P.F.S.

THE DEVELOPMENT OF THE TURPENTINE INDUSTRY IN GERMANY DURING THE WAR.

Cut off as it was from 1914 to 1918 from its ordinary source of supply of American rosin, of which the annual consumption amounted to 82,000 tons, Germany with characteristic thoroughness tackled the problem of developing its own sources of supply, and if the output of literature resulting bears any ratio to the output of home-produced rosin, one would have to admit the success of the venture. This literature is exhaustively and ably reviewed under the initials of "W. N. S." in the *Journal of Forestry* (Vol. XVII, No. 6, October 1919, pp. 729 to 742, published by the Society of American Foresters). The account is worthy of close study by Indian forest officers interested in the Indian oleo-resin industry, and the notes that follow, while in reality constituting mainly a review of a review, have as their principal object a brief critical survey of Indian methods with a comparison of results in Germany and India, in so far as this is possible at present or of practical value. According to Tubeuf the resin in Scotch pine trees, "secreted in some manner from food materials stored in the living parenchyma tissue which lines the walls of the resin ducts, is under pressure due to turgidity of the living cells. When one of these ducts is cut across, the pressure forces the resin out, until internal and external pressure are equalized." When the resin flow ceases owing to the hardening of the resin in contact with the air, internal pressure is again set up, and the operation is repeated when the resin duct is freshly cut.

Tschirch (see U. S. Forest Service Bulletin No. 90, 1911, pp. 25—30) some years previously had elaborated a different theory, attributing a small portion of the resin flow to physiological changes, but the larger part to a protective or pathological action. The latter theory seems to be borne out in Indian practice as it is often noticed that the flow from channels even when regularly refreshened is comparatively small till three or four weeks of the tapping season had gone by, when a heavier and regular flow of resin sets in. In any case the whole question will repay close study under Indian conditions as it may easily have a vital effect on the current basis of organizing resin production in this country. Incidentally the acceptance of Tubeuf's contentions would upset many of Meyer's well-known conclusions and that too strengthens the case for independent research in India. If Tubeuf's turgidity theory be accepted warm rains and warm sultry periods are specially favourable to an abundant flow of resin, while cold spells or hot drying winds are unfavourable. The adverse effect on resin flow of hot dry winds in the Murree block of Rawalpindi West Forest Division has been observed over and over again in the past four or five years.

A good deal of the literature under review deals with the best system of tapping, the American box cutting system, the French gutter system, the boring system and others being scrutinized. It is obvious that in Germany the main object was to obtain a maximum yield of resin compatible with the safety of the tree and consequently cheap or economical working was a side-issue. Therefore a two-day refreshing period is advocated, whereas in India E. A. Smythies has clearly demonstrated that refreshening five times a month gives the best economical results.*

The German investigators have with natural thoroughness worked out in full detail the yield of resin in grammes for certain units, such as per cent. of linear channels, per centimeter of circumference of tree and so on. There must be a natural limit to such thoroughness and Indian methods based as they

*Under present conditions in Kumaon.—HON. ED.

are on well-established French custom are probably the best we can adopt, always bearing in mind that Indian resin tapping coolies are illiterate, not over-intelligent and prone to shirk even what few precautions can be adopted with supervision often inadequate. In this connection it may be of interest to give modern French dimensions for resin cuts and channels as something Indian workers can aim at as Indian labour gets better trained and therefore under better control.

Year of Tapping.	Annual height increase of blaze.	Width of blaze	Depth of blaze
1st ...	21⅝	3½	0·39
2nd ...	23⅝"	3$\frac{5}{16}$"	0·39"
3rd ...	25½ ...	2¾"	0·39"
4th ...	25½" ..	2½"	0·39
5th	27½"	2"	0·39"

The average German tapping season appears to be one of 122 days, while the Indian one is nearer 180. German experience points to three to four kilogrammes (6·6 to 8·8 lbs.) per season per tree as about the maximum resin that can be obtained without bleeding the tree to death or interfering unduly with timber increment. Here, clearly, Indian investigators have a rich field for research, and in view of the extending activity of the oleo-resin industry in the United Provinces and the Punjab, this is also a factor working plans officers will, in future, have to take into account in calculating the increment of *Pinus longifolia* crops when subject to continuous light tapping. In India a collection of 6¾ lbs. of resin per season per tree represents a fair average.

It is interesting to read that in Germany they can count on 250 trees to be tapped per hectare (2·47 acres), or say 100 trees per acre. In India 25 trees per acre is a good average for the Punjab, and it is less in the United Provinces. The average German yield per hectare is given in the literature under review

at 750-1500 kgms., or taking the lower figure 663 lbs. per acre,* whereas a good yield in India is 182 lbs. per acre (Kangra Division actual, 1919 season's tapping). In this connection Appendix I to these notes shows what can be obtained, week by week, from resin collections in the Punjab *Pinus longifolia* belt. Such figures in course of time, combined as they are with observations in regard to climate, etc., should ultimately provide data of what maxima can be expected in resin harvesting under Indian conditions.

Forstmeister Aueroch brings out the fact that the thinning down of the outer bark of the pine trees preparatory to cutting the channels should not be done until just before refreshening begins, because increased evaporation or decreased bark pressure, or both, result in decreased flow of resin. The same observer has interesting remarks on the effect of the age of stand, rate of growth, site conditions, metereological conditions, etc., on the quantity of resin, and similar data for India should be collected as opportunity offers. The effect of tapping on the health of the tree and the quality of the wood is dealt with by Tubeuf. The prevalence of *Trametes Pini* and other fungoidal diseases in India makes this enquiry of special interest to Indian Foresters.

Enough has been written to show how even such a simple matter as gashing a tree to harvest its resin is hedged in by a mass of intricate problems, whose elucidation is necessary if only to justify existing practice, but more so to make sure that present conditions of prosperity in the resin industry are not piling up unthought-of malign conditions inimical to the future of the principal Indian pine forests. Viewed from this stand-point it may be asserted that a case for independent investigation of these problems in India has been made out and should be undertaken as soon as the special problem of shortage of trained Forest staff arising out of the war has had time to adjust itself.

In anticipation of such investigations these notes are perhaps best concluded by a list of recent and important literature on

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*These high figures appear to be the outcome of *heavy* tapping undertaken under the stress of the war.—HON. ED.

oleo resin and the special problems of its formation, harvesting and so forth.

Tubeuf ... Die Verwendung des deutschen Harzes. Naturwis-senschaftliche Zeitschrift fur Forst-und Land-wirtschaft. January-February, 1918, pp. 67 -70.

Tubeuf ... Uber die Beziehungen der Baumphysiologie zur praktischen Harznutzung. Ibid, pp. 1—17.

Munch ... Das Harzertragnis der gemeinen Keifer. Ibid., pp. 18—27.

Kienitz ... Versuche uber den Einfluss der Arr der Verwendung auf den Balsamfluss der gemeinen Keifer. Ibid., pp. 61—67.

Aueroch .. Untersuchungen und Erfahrungen bei der Harznutzung 1917. Ibid., pp. 35 -43.

Koehl ... Untersuchungen uber verschiedene Verfahren zur Harzgewinnung. Ibid., pp. 43—53.

Wislicenus .. Zur deutschen Kiefernterpentingewinnung mit geschlossenen Bohrungen und Harzbeuteln. Ibid., pp. 53—61.

Gundel .. Harznutzung 1917. Ibid., pp. 28—35.

Biehler .. Zur Harznutzung im Jahre 1917. Allgemeine Forest-und Jagdzeitung. August, 1918, pp. 149—165.

Kriegsausschuss, etc. Die Kiefernharznutzung 1918. Naturwissenschaftliche Zeitschrift. January-February 1918, pp. 70—78.

Schepss ... Zur Kiefernharznutzung 1918. Ibid., March-August, 1918, pp. 105—118.

Tubeuf ... Harznutzung der Fichtein Grafrath. Ibid., January-February, 1918, pp. 78 —98.

Penhallow, D. P. North American Gymnosperms, pp. 109—153.

Kirsch, Simon ... The Origin and Development of Resin Canals in the Coniferæ with Special Reference to the Development of Tyloses and their

Corelation with the Thylosal Strands of the Pteridophytes, Proc. Royal Soc, of Canada, 1911.

Foxworthy, Fred W. ... Philippine Dipterocarpaceæ. Phil. Journal of Science, C. Botany, Vol. VI, No. 4, Sept. 1911, pp. 231—287.

Solereder, H. ... Anotomy of the Dicotyledons, Vol. II, pp. 1101—1102.

Tschirch, A. ... Die Harze und die Harzbehalter, Vol. II.

A. J. GIBSON,
I. F. S.

March 1920.

APPENDIX I.

Statement showing the average daily collection of resin per coolie (working a section of 1,000 channels) during the tapping season of 1919 in Kangra Division.

Area tapped 5,200 *acres*. *Trees tapped* 128,700. *Channels* 196,100 = (196 *coolies*).

Week	Average of previous years, seers.	1919 average, seers.	REMARKS.
2nd week of March ending 15-3-1919	2	...	
3rd ditto ending 22-3-1919 . .	2	3·80	
4th ditto ending 31-3-1919	4	4·00	
1st week of April ending 7-4-1919	6	4·68	
2nd ditto ending 15-4-1919 .	7	6·72	
3rd ditto ending 22-4-1919 .	9	8·44	
4th ditto ending 30-4-1919 ...	9	9·44	
1st week of May ending 7-5-1919	9	12·56	
2nd ditto ending 15-5-1919	10	14·70	
3rd ditto ending 22-5-1919 .. .	11	18·08	
4th ditto ending 31-5-1919	14	22·84	

THE INSECT PESTS OF LANTANA.

Lantana Insects in India, being the report on an enquiry into the efficiency of indigenous insect pests as a check on the spread of Lantana in India, by Rao Sahib Y. Ramachandra Rao, M.A., F.E.S., Entomological Assistant, Madras, (on special deputation on Lantana work under the Imperial Entomologist). *Mem. Dept. Agr., India, Ent. Series, Vol. V, No. 6, June* 1920 [pp. i–iv + 238—314, Plates XXIV—XXXVII, figs. 1—3; price Rs. 2 4.]

In Mexico, its reputed home, *Lantana aculeata (= camara)* supports a diverse association of some 400 species of insects, that keep it in complete check. But in the tropical countries,—*e.g.*, India, Ceylon, Hawaii, Queensland,—to which Lantana has been introduced as an ornamental shrub during the past century, a natural check does not occur, so that the plant, escaping from cultivation, has run wild and in favourable localities has displaced the native vegetation.

The possibility of controlling a noxious weed by means of a noxious insect makes a powerful appeal to the imagination. On the advice of their entomologist, Mr. A. Koebele, the Hawaiian Government in 1902 imported a series of insect pests, that attack Lantana in its natural habitat, and liberated them on the Lantana which had in the course of 50 years become a serious problem in the Islands. A few years later it was reported that the reproduction and spread of the weed was appreciably checked by the insects that bred in the flower-heads and ripening fruits. These satisfactory results were followed by introductions, particularly of a seed-fly, into other countries, *viz.*, in 1909 to New Caledonia, in 1911 to Fiji, in 1917 to Queensland, and an unsuccessful attempt by the Mysore Government in 1913. In the three localities named the seed-fly has become established and is considered to do excellent work. The Government of India, with commendable caution, decided in 1916 to carry out an enquiry "into the efficiency of the existing indigenous pests as a check on the spread of Lantana" before attempting the introduction of foreign seed parasites.

The survey of the insect fauna of *Lantana aculeata* has recently been completed by Rao Sahib Y. Ramachandra Rao, after nearly 2½ years' field work. He found less than 150 species of Indian or

Burmese insects feeding on the leaves or flowers or fruits of Lantana ; of this meagre total a large proportion is formed of more or less accidental visitors, of over-flow attacks from the normal food-plant, or of species eating Lantana *défaut de mieux*. Only a few species can be regarded as regular breeders on Lantana and they are mainly insects that utilize the flowers and fruits. Among them a small plume moth, *Platyptilia pusillidactyla*, W.k., (the caterpillars of which feed on the flower buds, flowers and unripe fruits, materially reducing the formation of healthy seeds), alone can be considered an efficient check on the reproduction of the plant. Other species that feed on the flower-heads, *e.g.*, the caterpillars of *Lobesia* spp. and *Cacocia* sp., and a gall-fly *Asphondylia* sp., as also the defoliators *Diacrisia* spp , *Euproctis* spp., *Olene* sp. and *Hypena* sp., occur in numbers too small to form an appreciable check.

Although the investigation was not undertaken primarily from the aspect of associational ecology, and was necessarily confined to a somewhat superficial survey, we are disappointed that Mr. Ramachandra Rao has not been able to throw more light on the interrelations of an introduced plant and the indigenous insect fauna of its adopted country. He concludes, however, that there does not exist in India a chain or association of indigenous insects, the artificial multiplication of which could be used as a practical method of preventing the spread of Lantana ; nor does there appear to be any hope of destroying established Lantana by insect agency, but it is suggested that " at least in parts of India, some insects are sufficiently numerous to serve as auxiliaries, if an efficient insect of the nature of the Lantana *Agromyza* [the seed-fly] were to be introduced." Mr. T. Bainbridge Fletcher, Imperial Entomologist, in a preface to the report, doubts whether any form of insect control will obviate altogether mechanical methods such as cutting and burning, and does not recommend the introduction of the seed-fly into India, at least until it has been ascertained that it will confine its attention to Lantana No suggestions for future work are made in the report but before dismissing the subject of insect control for Lantana, or waiting

for the entomologists of Hawaii and Australia to work out the food-habits of the seed-fly, we think it would be worth while to establish more precisely the economic value of *Platyptilia pusillidactyla* and of one or two associates.

The species is probably not indigenous but an early introduction to India ; it feeds also on *Lantana indica* and *Lippia geminata* (another imported American weed), and has been resident long enough to become subject to parasitism. Ecologically *pusillidactyla* is in the position that the seed-fly may be presumed to reach in 50 or 100 years time. We suggest that its presence in India (which amounts to a ready made introduction experiment) should not be disregarded, but should be used as a basis for comparison with the Hawaiian incidence.

As far as we are aware the glowing reports of the successful work of the seed-fly are not supported by statistical information or the most approximate estimates, and for this reason we do not agree to the importation of the pest to India. Moreover a seed-fly has recently been discovered effectively destroying Lantana berries in New South Wales, to which country the Mexican species has not knowingly been introduced.

Forest Officers will find the Memoir well worth reading ; apart from its entomological information an excellent account, amounting to 35 pages and illustrated with numerous photographs, is given, of the plant itself, its varieties, distribution and soil requirements.

C. F. C. B.

USES OF BRACKEN.

Value of bracken *(Pteris Aquilina)* as a fertilizer. Shutt F. T. in the Agricultural Gazette of Canada, Vol. VI, No. 4, pp. 328—329. Ottawa, April 1919.

Common bracken *(Pteris Aquilina*, L.*)* grows in large quantities in Canada, especially in the neighbourhood of the Pacific Ocean. A long time ago the author already drew attention to the value of bracken as a fertilizer. The plants also make excellent bedding material, largely on account of their capacity for

absorbing liquids and ammonia. Bracken litter used as a fertilizer has the same value as straw litter.

An analysis of air-dried bracken made in 1918 at the Agassiz Agricultural Station, British Colombia, gave the following results ;—Moisture 6·09 per cent., ash 7·84 per cent., nitrogen 1·84 per cent., phosphoric acid 0·68 per cent., potash 2·75 per cent.

Analyses made in the United Kingdom showed the ash of young bracken to contain 50 per cent. of potash. Its high nitrogen content gives bracken good fertilizing value.

The bracken is gathered in autumn and, if the weather conditions permit, even in winter. It should be noted that dried bracken rapidly loses its potash.

Recent investigations carried out in the Zootechnical branch of the Department of Agriculture of Canada showed that dried bracken present in hay may prove poisonous to horses. The best use to which bracken can be put is, therefore, to employ it as litter and to apply the litter as fertilizer. Green bracken may also be mixed directly with other fertilizers, or else burnt and the ashes utilized.

[*International Review of the Science and Practice of Agriculture*, Year X, No. 6.]

THE FIELD FOR WATERPROOF GLUES.

There is now obtainable from more than one source a casein veneer glue which is absolutely uniform and will invariably produce a strong panel and one which will stand the soaking or boiling test. Probably the most radical improvement from a practical point of view is the ability to hold the glue overnight, so that it can be retained in the mixer or spreaders and the run continued the next day. This has been accomplished by the inclusion in the formula of chemicals which not only accomplish the above result, but make a considerably less expensive glue because it takes a larger proportion of water On panels having face veneers not thicker than 1/16 in. a spread of from 60 to 70 ft. per pound of glue is obtained, and a higher spread is possible on thin veneer, with smooth-roll spreaders.

Proper spreading of casein glue puts a comparatively small amount of glue between the veneers, whereas during the war it was necessary to convert a panel into a veritable cheese sandwich, with a tremendous squeeze-out. If panels so made are handled within twenty-four to forty-eight hours after they are glued up, the knives will stand up better under casein glues than they do with animal or vegetable glues.

I am probably not giving you any news when I tell you that the number of new plants is simply enormous, to say nothing of the plants heretofore devoted to other lines of manufacture which have turned their production into panels. I refer to such concerns as the American Car and Foundry Co., Pullman Parlor Car Co., and any number of furniture concerns. This undoubtedly means that within a certain period of time and from present indications, not so very long from the present, there is going to be a large overproduction of panels if they are to be consumed exclusively in channels which heretofore existed.

Of the new fields opened by the waterproof proposition, perhaps the automobile field has developed more rapidly than any other. There are now two panel plants whose entire output is devoted to the manufacture of plywood wheels, and these wheels are now going into automobiles and are apparently very satisfactory. For tops there is already a tremendous demand. One concern, as you all doubtless know, is making a very large production of waterproof plywood tops. Half a dozen large automobile-body builders are now using plywood in the manufacture of ribs, roof beams, and other curved braces which were formerly made of lumber, and the plywood construction is much stronger, lighter and cheaper.

Probably the most interesting development in connection with automobiles is the use of plywood for the building of the whole body to replace the metal, and some very large concerns have built experimental bodies with a good deal of success. There is one concern that has built a five-passenger sedan body weighing 120 lbs. which is just about one-third of the weight of an aluminum body of the same cubic capacity. One concern in

Buffalo is said to be in active production of a body made completely of plywood. I have seen a 'bus body with a double deck built of plywood practically throughout and weighing about 20 per cent less than a single 'bus body of the same size under the old form of construction. I cannot see any reason why the automobile industry should not take a tremendous quantity of waterproof plywood in the future for the same reason that plywood was adopted for aircraft construction, because it is the material which has the greatest strength per unit of weight. It takes more gas to pull a 5,000 lb. car than it does to pull a 2,000 lb. car.

Probably the next important source of consumption is in the transatlantic steamer, and in this connection the Europeans seem to be far ahead of the Americans. We have received enquiries for hundreds of thousands of feet of plywood to form the partitions between the cabins of passenger steamers. These panels are usually wanted in from 5/8 to 1 in. in thickness and average about 5 ft. wide and from 6½ to 8 ft. in length. The English want gum; the French want birch. The American shipbuilders are not particular as to the kind of wood, it being remembered that all of these panels are heavily painted. When the Leviathan was converted to transport service it was found that the partitions were made of waterproof three-ply, with a 7/8 in. pine core and ⅛ in. mahogany faces.

There are innumerable minor fields which have adopted waterproof plywood in an experimental way, which include wire reel manufacture, sporting goods manufacture, outdoor toy manufacture, and one of the most unique is shoe manufacture. We supplied a quantity of plywood to a concern which has made up its shoes of part plywood construction, including soles and heels, this latter being made of five-ply 3/8 in. birch, and being so inserted in the shoe that when they wear out they can be replaced by the wearer in a few minutes.

[Extract from a paper by Mr. L. Ottinger quoted from "Veneers," a Journal for Veneer Manufacturers and Users, July 1920, U. S. A.]

Photo.-Mech. Dept., Thomason College, Roorkee.

Dalbergia latifolia showing prolific growth of root suckers.

VOLUME XLVI NUMBER 11

INDIAN FORESTER

NOVEMBER, 1920.

THE UTILIZATION OF BAMBOO FOR THE MANUFACTURE OF PAPER PULP.

[The large number of enquiries being received at the Forest Research Institute on this subject suggests that a summary of the note published in 1912 and reprinted in 1916, by Mr. R. S. Pearson, the Forest Economist, revised and brought up to date by himself cannot fail to be of interest to readers of the *Indian Forester*. —HON. ED.]

The idea of manufacturing paper-pulp from the raw materials available from the forests of India, dates back nearly sixty years, though it is only in the last few years that schemes have materialized in India to start factories utilizing bamboos.

Justification for this note.—Since Messrs. Sindall and Raitt published their reports on bamboo for the manufacture of pulp in 1909 and 1912 respectively and since the publication of the writer's note on the same subject, a considerable amount of progress has been made in perfecting processes of manufacture and in searching for further suitable areas from which bamboos can be extracted to a possible factory site at sufficiently low rates to attract the attention of possible users. The

object in the writer's mind in publishing this article is briefly to review pre- and post-war conditions and to bring the available information up to date.

Raw materials used in India.—In pre-war days the standard materials used in India for the manufacture of paper-pulp were Sabai or Babar grass (*Ischœmum angustifolium*), sulphite spruce, and mechanical wood-pulp, of which the former is a grass found in Bengal, Nepal, Orissa, the Central Provinces and the United Provinces, while the latter two are imported as dry pulp. Limited quantities of rags, hemp, jute, gunny, waste paper and ropes, all more or less of the class of rejections, were also used to help out the supply of raw material.

Effect of war conditions on the paper industry.—The effect of the war soon began to make itself felt, the price of imported mechanical and chemical pulp went up by leaps and bounds, while the quantity was gradually reduced to one-sixth of that landed in this country in 1912-13. The same may be said of imported paper with the obvious result that the price of Indian-made paper rose to previously unheard-of rates, while the demand was far in excess of the supply. The Indian paper mills may be said to have met the altered conditions of affairs in a very praiseworthy and prompt manner, which they were in a measure able to do owing to the fact that they were in a position to pay much higher prices for raw material than under pre-war conditions. The paper-makers had, however, other very serious difficulties to overcome: to begin with, in nearly all Indian mills the machinery had been working for many years and was out of date, while to obtain new parts became increasingly difficult as the war went on. In spite of this, practically every mill in India was able to more than double its outturn before the armistice was signed. Then again, following upon the great reduction of imports of mechanical and chemical pulp, paper-makers had to look elsewhere for material with which to manufacture pulp, and they scoured India in their endeavours to find anything resembling suitable fibres. Search was made for new Sabai areas, and this resulted in a greater demand for the grass of the Siwalik areas, while they also went further

afield in Nepal, Orissa and Central Provinces. In those days it was not unusual to see filthy heaps of old rag, much damaged jute and hemp and piles of what may or may not have been gunny, which in pre-war days a pulp-maker would not have allowed within the gates of his mill, lying in the yards and godowns of Indian pulp and paper mills. It was not surprising, therefore, after all the talk and writing about bamboo as a possible fibre-yielding material, that the eyes of pulp-makers should turn in that direction. As a matter of fact considerable quantities of bamboo were at one time or another used to help out deficient supplies of grass. It was known by certain interested parties before the war that bamboo was one of the coming major raw products for the manufacture of paper-pulp, and it may be of historic interest to state that one of the largest paper-making firms in India was so certain of the possibility of being able to manufacture bamboo pulp at a profit when, be it said, imported chemical pulp could be obtained in Calcutta at from £9 10s. to £10 per ton, that the firm had placed an order for a large bamboo pulp mill some two months before war broke out. The war temporarily frustrated the scheme, though with chemical pulp now selling in England at £55 to £70 per ton and the cost of manufacture of bamboo pulp in India not materially increased by post-war conditions, the proposition speaks for itself.

Supplies of raw material in future.—Turning now for a moment to the present position of raw material all over the world. Wood supplies 90 per cent. or more of the raw material used in paper-making and will continue to do so for some time. It is unnecessary to repeat the warning note about a shortage of wood, the alarm has often been shouted from the house tops and is accepted as a fact.

The supply is, however, not yet exhausted. War has seriously cut into our stores, nevertheless wood is still forthcoming albeit at much higher prices. That for the moment is the crux of the whole business and is driving people to turn their eyes more and more towards bamboos. Later, as supplies of timber become still scarcer bamboo-pulp is likely gradually to become a serious competitor of chemical, though not of mechanical, wood-pulp.

Indian conditions are not quite the same as in Europe. As far as we know at present the question of manufacturing wood-pulp in large quantities in India is not possible, if for no other reason than that the coniferous woods of the Himalayas fetch better prices for other purposes than are admissible in the manufacture of pulp. Sabai grass is little inferior to esparto for pulp making, and the most fervent supporter of bamboo has never suggested that bamboo will ever oust Sabai from the position it holds with Indian paper-makers. Where bamboo-pulp is likely to come in, anyhow as far as Indian conditions are concerned, is as a competitor of imported chemical wood-pulp and later to find its way into the markets of the world as a recognized material for paper making.

Imports of paper and pulp.—Let us study for a moment the figures of imports of (i) paper, paste-boards, etc., and (ii) wood-pulp since 1912-13, in order to see the position as it stood in normal times and under war conditions :—

Article.	Value.						
	1912-13.	1913-14.	1914-15.	1915-16.	1916-17.	1917-18.	1918-19.
	£	£	£	£	£	£	£
Packing paper	65,315	73,341	72,264	99,863	92,651	77,717	1,16,455
Printing paper	2,89,198	3,27,380	2,78,709	2,99,321	5,83,038	4,54,275	0 04,682
Writing paper and envelopes ...	2,24,458	2,59,964	1,69,925	1,88,720	3,54,333	2,65,322	3,26,757
Other kinds of paper ...	3,40,511	3,40,822	3,09,899	3,12,808	4,50,661	5,95,075	3,73,964
Paste-boards, Mill-boards, etc.	44,485	56,947	48,501	60,890	73,308	1,04,424	1,88,788
Total Paper, Paste-boards, Printing paper, etc.	9,63,967	10,58,454	8,79,298	9,61,602	15,53,991	15,40,813	18,13,779
Total Wood-pulp ..	1,11,049	1,15,809	92,581	1,21,198	1,99,310	1,14,545	74,211

Article.	Quantity.						
	1912-13.	1913-14.	1914-15	1915-16.	1916-17.	1917-18	1918-19
	Cwt	Cwt.	Cwt.	Cwt.	Cwt.	Cwt.	Cwt.
Packing paper .	1,09,040	1,29,317	1,70195	1,52,582	72,749	38,337	37,755
Printing paper	3,36,939	4,02,230	3,26,895	3,20,934	3,20,719	1,89,875	1,94,603
Writing paper and envelopes ..	...	...	...	...	...		...
Other kinds of paper ..	5,52,860	4,85,873	4,37,061	3,74,626	2,61,069	1,91,406	86,350
Paste-boards, Mill-boards, etc	96,207	1,07,119	92,743	1,21,513	1,31,973	1,05,790	1,14,058
Total Paper, Paste-boards Printing paper, etc.	...	...	...	...	...		...
Total Wood-pulp ...	2,65,002	2,47,636	1,79,510	2,10,989	1,68,609	71,940	41,801

The figures in the above table give a true indication of the position of affairs in the pulp and paper trade of India before 1913 and during the war. The figures of value of imports are not so instructive as those showing quantity, as owing to the ever-increasing cost of all classes of paper and wood-pulp, the declining imports were counterbalanced by the rising prices. Compare, for instance, the amount of "packing paper" imported in 1912-13 with that for 1918-19; it decreased roughly to one-third in the latter year, or refer to the figures for "other kinds of paper," the amount of which was reduced by two and a half times. What concern us most for the moment are the figures of imported pulp, which *in 1912-13 stood at 2,65,002 cwt. and in 1918-19* at *41,801 cwt.*, the decrease being undoubtedly due to submarine warfare. When it is realized that the outturn of paper in 1912-13 from Indian paper mills was in the neighbourhood of 22,000 tons, that it was increased in 1918-19 to approximately 35,000 to 38,000 tons, that in pre-war years about 12,000 tons of chemical and mechanical pulp were imported and finally that these imports were ultimately reduced to 2,000 tons, it will readily be understood that it was possible to find the necessary raw materials, at a price, in this country. It must also be mentioned that the quality of paper produced during the war was not up to the old standard. It may with justice be asked, why not go back to pre-war conditions and again import chemical and mechanical pulp. The reply is that apart from the difficulty of obtaining supplies, the cost of importation is prohibitive if the present prices of paper are ever to be reduced to even reasonable figures. The solution, which has already been referred to elsewhere, is considered to be the utilization of bamboos and possibly when further investigations have been carried out of Savannah grasses also for the manufacture of pulp.

General conditions necessary for the successful establishment of a paper-pulp mill.—A good number of the enquiries made from the Forest Research Institute with reference to establishing bamboo-pulp mills, tend to show that in some quarters the idea is held that to start such an enterprise is a relatively simple matter. As a matter of fact the necessary conditions for the successful establishment

of a paper-pulp mill are manifold and can only be found in a few localities. It may, therefore, be of help to interested parties, again to state the most important conditions necessary to ensure success :—

The first is that a sustained annual yield of a suitable raw material for the manufacture of pulp be available. In the case of bamboo the minimum amount admissible is put at 20,000 tons of air-dried bamboo per annum ; the second that the cost of extraction of the same can be kept within economic limits for many years to come. For bamboos the maximum price is put at Rs. 15 per ton of air-dried nodes and internodes, landed at a mill. The figure of cost given above is not based on the present value of pulp, which cannot be expected to maintain its present high level, but has been fixed on rates more approximating to those ruling before the war ; the third that the raw material should have little or no local value or should be available in such quantities that the requirements of a mill do not interfere with any present or prospective local demands ; the fourth that the crop from which the raw material is drawn be concentrated, in other words gregarious, in order to reduce supervision to a minimum ; the fifth that the factory be so situated that the raw material can be floated or brought into the mill by other means through the greater part of the year and that the lines of import for chemicals, coal, etc., and of export of pulp lead direct to a seaport. Preferably the factory site should be on a river draining the catchment area from which the raw material is obtained and have water connection with a seaport. The distance by water from the forest to the factory is not a matter of such great importance as that from the factory to the seaport, which should be as short as possible ; the sixth that lime be available in quantity at cheap rates ; the seventh that a large supply of fresh water be available throughout the year. This is a point of great importance and one which requires careful investigation by an expert ; the eighth that labour be available in sufficient quantity for extraction work and to run the mill ; the ninth that the locality be reasonably healthy ; the tenth that

in the case of bamboo, a careful study be made of past, present and future cycles of flowering. In this connection those areas in which two or more species of bamboo occur are preferable to areas yielding only one species (this point is referred to later in this note); the eleventh and last that the river be not subject to excessive floods or long periods of dryness.

Suitable localities for the extraction of bamboos.—From what has been said above, it will be understood that the number of localities in India and Burma, which fully meet all the above conditions, are necessarily limited. It is thought that certain areas in Lower Burma do so, such as areas on the Eastern and Western slopes of the Pegu Yomas, which drain into the Sittang and Rangoon or Myitmaka rivers, as also certain areas in Tavoy. Again, there are at least three large catchment areas in Arakan, namely, the Lemro, Kaladan and Seik rivers, all of which drain areas rich in bamboos. Going further up the coast to Chittagong, there is at least one area on the Chittagong river which drains the Chittagong Hill Tracts forests. On the West Coast of India, several suitable areas are to be found, from Goa southwards to Cochin, in the catchment areas of the numerous streams draining the forests of the Western Ghats. Then again, a not unattractive area exists in the Surat Dangs and another possible area in the Hoshangabad Division of the Central Provinces. The catchment areas of the East Coast have not as yet been inspected with special reference to the extraction of bamboos for the manufacture of pulp, though it will be necessary to carry out such surveys, especially in the Godaveri and Mahanadi basins.

Bamboos, their mode of growth and possible outturn.—In Chapter II, Indian Forest Records, Vol. IV, Part V, the question of the growth of different species of bamboos is fully dealt with and need not be repeated. Since that note was written in 1912, the flowering of various species of bamboo has taken place in widely distributed areas. This has afforded unique opportunities to study this question, which is all-important in connection with the bamboo-pulp industry.

Flowering of Bambusa arundinacea.—For instance, *Bambusa arundinacea* has flowered all over the West Coast, and a special inspection was made in 1917 of the forests in Kanara of the Bombay Presidency. The results of this inspection were noted at the time and are given below :—

Inspection Note, dated 30th January 1917, by the Forest Economist, on some of the Kanara forests in connection with the supply of bamboos suitable for paper-pulp.

I inspected some of the bamboo areas in Kanara, marching from Karwar *viâ* Anshi, Khumbawara, Supa and Dandeli to Tavargatti. Generally speaking *Bambusa arundinacea* has flowered in Kanara from east to west and north to south, so that the more advanced growth is in the north-west area of the block, where flowering took place about 1908-1909. The flowering is not yet complete, in fact in the Kalanadi valley up to Shivpur Nala flowering has not taken place.

At Anshi, which is on the top edge of the Ghats, the bamboo has not generally flowered, though a few scattered clumps here and there have done so, a circumstance indicating that universal flowering will probably take place next year, which again will probably be followed in the succeeding year by flowering on the Ghat slopes and along the river.

Flowering has taken place three or four years ago in areas between Anshi and Supa and the plants are now about four to six feet high and form a dense mass on the ground. After leaving Supa, as one goes towards Birchi, the bamboos have flowered about five years ago and individual plants have put out culms 12 to 15 feet high, while round Dandeli and near Gund some of the plants are now 30 feet high. Mr. Bell stated that in the East Division of Kanara the growth was even more advanced than round Dandeli and that in many places it was very dense on the ground.

Both Mr. Bell and Mr. Marjoribanks were of opinion that the more advanced growth, as for instance in Gund, round Supa and Dandeli would not be fit to cut for another four years and I agree with them. The position, therefore, amounts to this, that

bamboos cannot be extracted from the outer ridges of the Kalanadi catchment area for another four years, and as the bamboos in the valley between Karwar and Shivpur have yet to flower, it will be ten or twelve years before the new stems will be available from this portion of the area. From what has been said it is clear that a pulp factory can in no way work for at least four years, and will then have to obtain its supplies from above the Shivpur Nala, while if the assumption is correct that the bamboos will not flower in the Kalanadi up to the Shivpur Nala for another two years, the old green and (after flowering dry stems will be available up till five years from now, as they can be used for at least two and even three years after they have flowered. This only applies to *Bambusa arundinacea*. This means that if the pulp factory were started four years hence there would be a supply of fresh bamboos from Gund and eastward and also a limited supply of dry culms from the valley. This would be sufficient to carry on with until the bamboos are available in greater quantities from areas that have flowered more recently. When discussing this subject with various forest officers, we all agreed that nothing could be done for at least four years, counting from the monsoon of 1917.

Flowering of Melocanna bambusoides.—Muli bamboo is supposed to flower every 30 to 35 years. While inspecting areas in connection with their extraction for pulp, the writer noticed in 1912 nearly universal flowering in the forests of Cachar, Assam, and flowering in patches in Arakan in 1910. While inspecting the forests of the Kasalong Reserve in the Chittagong Hill Tracts in 1919, it was ascertained that Muli had flowered from 1908 to 1912 in these areas, and that at the time of inspection some eight years later the culms had developed sufficiently to allow of their being cut for commercial purposes.

Flowering of Cephalostachyum pergracile.—In the Zamayi bamboo area of the Pegu Division, Tinwa bamboo was noticed to have flowered as many as five years previous to the date of inspection in March 1918, though the main flowering must have taken place in 1915-16. Other Tinwa areas have also flowered in Burma so that it is probable that a general flowering

of this species has taken place. It was thought from the general state of growth of Tinwa regeneration, which was profuse in Pegu, that the seedlings would commence to form clumps in the fifth to sixth year from the time the seed germinated and that culms suitable for extraction would be available by the tenth year.

Flowering of Bambusa polymorpha.—Kyathaung flowered in Tharrawaddy in 1852, and in the Pegu Yomas in 1859-1860, which appears to have been a period of general flowering in Burma. Reports began to come in of the flowering of this species in Burma in 1912-13 from the Prome and Minbu Divisions, while in 1917, Zigon, Tharrawaddy, Insein, Myaunglebin and the South Shan States all reported sporadic flowering. From still more recent reports it is clear that a general flowering of this species is now taking place in Burma, and as this bamboo is from a pulp-making point of view the major species, it will be imperative for all persons interested in bamboo areas in Burma to make a very careful survey of the condition of affairs before committing themselves to any undertaking in connection with pulp-making.

Even with this flowering taking place it is thought that it will be possible to obtain sufficient supplies to run a mill, though it may result in the raw material costing more until Kyathaung is again available, for over large areas this species is mixed with Tinwa and even alternates with *Dendrocalamus strictus.*

Flowering of Dendrocalamus longispathus.—Orah bamboo flowered in the Chittagong Hill Tracts in 1879, and after 40 years is beginning to flower again in that locality. Culms will, therefore, not be available for cutting for eight to ten years. In Burma it is said to have flowered in different localities in 1862, 1871, 1875 and 1891. Brandis states that it flowers frequently.

Flowering of Bambusa Tulda.—Tulda is said to have flowered 25 to 30 years ago in the Chittagong Hill Tracts. The Forest Botanist states that it flowered in Bengal in 1867 to 1872 and again in 1884. In Burma it flowered in various divisions from

1908 to 1916, the main flowering having taken place between 1908 and 1914. It is a species that flowers irregularly and not infrequently by single clumps.

Observations of flowering of bamboos.—From what has been said on this subject it will be seen that the more important species of bamboo which are likely to play an important rôle in the manufacture of pulp have flowered quite recently or are in the process of flowering; in other words that the keen interests now manifested in starting the bamboo-pulp industry coincides with the period of flowering of our more common species of bamboo. The importance of this point cannot be over-estimated when it is taken into consideration that these species will probably not flower again for from 30 to 40 years.

A point concerning the yield.—Another point of importance to be borne in mind in this connection is the yield of air-dry bamboo per acre, which is the basis of calculation for the yield of the whole area. In calculating the annual yield from stated areas, given in Indian Forest Records, Vol. IV, Part V, bamboos were cut over sample areas and weighed when dry in order to ascertain the yield per acre. These sample plots were taken in areas of average growth, but as at the time of operation many of the species of bamboo were approaching the period of flowering, a condition of affairs not known at the time, the culms must have attained their maximum growth. It, therefore, follows that the figures obtained are probably slightly above normal. As conditions now stand, in areas where bamboos have recently flowered, the amount of raw material will be least and the cost of extraction greatest during the first years of working while the yield will tend to increase and the price of extraction to fall with every successive year.

Investigations on treatment of Bamboos carried out in India.—Considerable advance has been made in the process of preparing bamboo-pulp. Mr. W. Raitt, now appointed officer-in-charge of Paper-pulp at the Forest Research Institute, has steadily prosecuted his enquiries since publishing his treatise in 1912, Indian

Forest Records, Vol. III, Part III. His labours have resulted in his devising a new way of treating bamboos, which he terms fractional digestion. The process entails a preliminary treatment of the bamboos with a very dilute solution of caustic soda, which facilitates digestion and, what is even more important, facilitates bleaching and so reduces the cost of production. By introducing a battery of cylinders in which preliminary treatment takes place, he is able to use spent liquors and so economise in caustic, while the digesters are so arranged that the bamboo chips can be blown from one to the other without further handling. In order to prove the efficiency of this process, as also to further the prosecution of all investigations connected with possible pulp-yielding fibres in India, an experimental pulp plant and paper machine capable of dealing with 10 cwt. of raw material has been ordered in England and is being prepared under the supervision of Mr. Raitt. This plant, when ready, will be erected at the Forest Research Institute, Dehra Dun.

While Mr. Raitt has been engaged on perfecting his "fractional digestion" process, others have been carrying on investigations in other directions. Mr. Bryce, General Manager of the Titaghur Mills, has done invaluable work both on bamboos and in testing various species of Elephant grasses, and it is largely due to his exertions and ability that it has been possible to commercialise the bamboo pulp proposition. In this connection the best thanks of the Forest Research Institute are due, not only to Mr. Bryce, but also to Messrs. F. W. Heilgers, the Managing Agents of the Titaghur Paper Mills, for allowing us to send many samples of bamboo and grasses to be tested, and for giving us valuable reports on the same.

Investigations carried out in Scotland.—While investigations have been carried on in India, others have been carried on in Scotland by an eminent pulp and paper manufacturer at Penicuick. The exact process is not known at present, but is said to be based on the sulphite process and has been patented. It is claimed that good bamboo pulp can be manufactured by this process at considerably lower cost than by any soda process.

All that can be at present stated is that the paper produced by this process is of excellent quality and equal to that produced by the soda process.

Utilization of nodes and internodes.—When the bamboo enquiry was reopened in 1905 by Mr. Sindall and taken up by the writer in 1910, the idea was that only internodes of bamboos could be used in the manufacture of pulp, and it was not until 1912 it was discovered that by crushing bamboos between heavy rollers and then chopping them into small pieces that both nodes and internodes could be utilized together. This change in the position of affairs signalised an important step forward in the enquiry.

Cost of production.—The investigations carried out in recent years have not only tended to improve the quality of pulp produced, but have tended to reduce the cost of preparation. On the other hand, the cost of labour, wages, coal and chemicals has gone up since the war, so that it cannot be definitely stated what the ultimate cost of producing one ton of air-dried pulp will be. On page 39 of Indian Forest Records, Vol. IV, Part V, it is put at Rs. 118-6-0 per ton of unbleached pulp and reasons are given for fixing that figure. Mr. Raitt on page 35 of Indian Forest Records, Vol. III, Part III, gives the cost as Rs. 92-8-0 per ton of air-dried unbleached pulp. Taking into consideration the improvements in manufacture as against the higher cost of labour, chemicals, coal, etc, it is thought that bamboo soda pulp can still be produced well within Rs. 125 per ton.

(To be continued.)

POISONING *BAUHINIA VAHLII.*

The question of poisoning climbers has been pondered over for some time in India. To discover a cheap and effective way of eradicating them was put down some years ago as part of the programme for the Silviculturist at Dehra Dun. An experiment was commenced at Thano in the Dun in April 1917 but was abandoned in December 1918. Exactly why is not clear. The writer has visited the area several times in the last six months and finally decided to make a further set of observations and place on record what has happened.

There are unfortunately considerable difficulties in carrying out such an experiment from the Central Institute. Constant inspection, so necessary for such work, is often out of the question when the Silviculturist and his assistant are away for considerable periods. It is probable that the experiment was abandoned because the results were felt to be inconclusive and it is for the same reason that they cannot now be published as a finished work from the Institute. On the other hand the provinces are still interested in this matter and as they can take it up on such a scale that conclusive results should be obtained, it may be of some use to them to know the little that has been done at Dehra Dun.

It was here one small item in a large programme and consequently the area and time devoted to it were quite inadequate to solve the problem. Actually some 46 climbers were treated of varying size. But as varying substances had to be tried, and as the climbers were treated at various heights from the ground and as also some were split, others cut and the surface treated and others merely bored into and the poison poured in, it ended in there being so many possible combinations and so few climbers treated that it was quite impossible to come to any definite conclusions as to the best method to adopt.

On the other hand if the substance applied alone is taken into consideration there are three or four climbers treated with each substance and it is possible to conclude that one poison is

more efficacious than another though the cheapest and best method of its application must remain the subject of further experiment.

The last observations were made three years after the commencement of the experiment, so it may fairly be assumed that those climbers noted as dead now really are so. The following points are noticeable as results of the treatment with various substances :—

Pure lime.—Out of four climbers treated one is dead, two are vigorous and another, though dead now, appears to have died from some other cause. It certainly had a lot of shoots which had only recently died.

Pure sulphur.—Out of four climbers treated only one is dead and the other three vigorous. The dead one was split before application.

Lime and sulphur mixed.—Out of four climbers treated two are dead and two are alive but weakly. The two dead ones were split before application.

Ferrous sulphate.—Out of four climbers treated two are dead and two are alive. The two dead ones were split before application.

Nitrate of potash.—Out of four climbers treated two are dead, one weak and one with vigorous shoots. One split and one cut climber died.

Common salt.—Out of nine climbers treated two are dead and a third dead but with root-shoots now coming up. Of the dead climbers one was split and the other cut.

Permanganate of potash.—Out of five climbers treated one is dead, two are weak and the others alive. The dead one was bored into and the poison poured in.

Sulphuric Acid.—Of three climbers treated one only is dead and that was cut. None were split before application and splitting may be better than cutting.

Mercuric chloride.—Out of three climbers treated two are dead. One was bored and the other cut.

Sodium arsenite.—Out of three climbers cut two are dead and the third could not be found but is probably dead as it had been killed to the base two years ago.

Creosote.—Out of four climbers treated two are dead and two alive. Of the dead ones one was bored with two holes, and one cut. None were split.

It appears that almost any of the above substances *may* kill climbers but that sulphur, permanganate of potash and common salt are the least certain in their action and that the climber recovers more often than not.

Lime, mixed sulphur and lime, ferrous sulphate, and nitrate of potash are also rather uncertain in their action and are not to be recommended.

Sulphuric acid and creosote seem as uncertain as the above but none of the climbers treated were split. It appears that cutting and splitting before application is better than cutting alone and it is possible that if this were done both sulphuric acid and creosote would kill the climbers.

Mercuric chloride and sodium arsenite seem to be the two most reliable substances tried. It is true that one of the climbers treated with mercuric chloride is still alive but it has apparently had a big struggle.

On the whole it seems fairly certain that if the climbers are cut, split and mercuric chloride or sodium arsenite are poured on they will be killed with one application. A 5% solution was used. Unfortunately both substances are poisonous to animals.

Perhaps the most noteworthy point in the detailed list below is the number of instances in which the stem appears to have been completely killed but the climber remains alive by means of root-shoots.

The experiment is vitiated to some degree owing to the fact that the area was not closed to grazing and besides being grazed by domestic animals the young shoots of the cut stumps were doubtless nibbled by deer. This however happens in nearly every forest in which climber cutting takes place.

It is quite impossible to give any idea of costs from this experiment as there seems to be no record of the amount of solution actually used and rates for coolies are always exceptionally high in working from the Institute and the amount of work done small.

Local silviculturists who are taking up this problem may find the above notes of some help to them.

S. H. HOWARD,
I.F.S.,
Silviculturist.

[We shall be glad to hear the results of any similar experiments from our readers, especially those which have been carried out on a practical scale.—HON. ED.]

BAUHINIA VAHLII.

Serial No.	Girth of climber	Height at which cut.	Method of application 11-4-17.	Subsequent observations on 6-7-17.	17-7-18.	17-12-18.	10-5-20.
				Pure Lime.			
1	48" at 1 ft	3'	Forked at 2 ft. Fork split and lime introduced. Both forks split.	Top part killed. But 12 new shoots from top and sides.	Poisoned part killed, but new shoots stout and green	No real damage.	Dead. A lot of dead shoots.
2	2" at 6"	1'	Split and lime placed in split	5 shoots from below ground.	Poisoned part killed, shoots vigorous.	Killed at top, but shoots from base of split.	Recently sent up strong root-shoots.
3	32"	2'	Lime placed on surface which was cut into pockets to hold lime, (cut slanting to make a horizontal surface).	No new shoots ...	Dead, but not rotten.	Quite dead ...	Quite dead.
4	37"	2'	Ditto ...	3 shoots ...	Poisoned part dead. Shoots stout and green.	Stem horizontal. Top of cut has died, but good shoots from below, and from undande of apex.	Vigorous root shoots.

				Pure Sulphur.			
5	17" at 1 ft.	2'	Split, and Sulphur poure in.	Dying, no shoots	Dead ...	Quite dead ...	Quite dead.
6	17" at 3 ft.	3'	Ditto ...	Ditto ...	Poisoned part killed. New shoots from below ground.	Ditto ...	Vigorous root-shoots.
7	24" + 17"	2'	Forked; sulphur placed on surface in pockets.	4 shoots ...	Poisoned part killed. Shoots stout.	Killed down for 1 foot.	Alive and vigorous.
8	14" at $2\frac{1}{2}$ ft.	$2\frac{1}{2}$'	Ditto ...	6 shoots ..	Poisoned part killed, shoots green.	Horizontal stem with slanting cut. No real damage.	Ditto.
				Lime and Sulphur mixed.			
9	31"	2'	Split and lime and sulphur inserted.	6 new shoots ..	Dead ...	Quite dead ...	Dead.
10	15"	2'	Ditto ...	6 new shoots. (Probably not well split and doped.)	Numerous healthy shoots.	No real damage. A second shoot is present which acting as sap-lifter has kept roots alive.	Do.
11	28"	2'	Lime and sulphur placed on cut surface in pockets.	1 new shoot from 6" below ground.	Dead, but root-shoots now appearing.	Killed down to base; strong root-shoots.	Weak shoots.

BAUHINIA VAHLII.

Serial No.	Girth of climber.	Height at which cut.	Method of application 11-4-17.	Subsequent observations on 6-7-17.	17-7-18.	17-12-18.	10-5-20.
12	36"	3'	Lime and sulphur placed on cut surface in pockets, (cut at 3' along ground).	1 new shoot from ground level.	Dead and rotten	Quite dead ...	Recently sent up root-shoots.
				Ferrous Sulphate.			
13	32"	2'	Split and ferrous sulphate inserted	3 new shoots from 6" below ground.	Poisoned part dead, shoots poor.	Several weak shoots. Might die.	Dead
14	34"	1'	Ditto ..	2 new shoots from 6" below ground.	Poisoned part dead; numerous root-shoots of this year.	Killed back to base. Weak shoots from roots.	Dead.
15	20"	2'	Ferrous sulphate placed on cut surface in pockets.	2 new shoots from 6" below ground.	Poisoned part dead; some new shoots this year.		Recently sent up strong root-shoots.
16	22"	2'	Ditto .	2 new shoots from ground level.	Poisoned part dead, some healthy shoots.	Killed to base several healthy root-shoots. (Sap-lifter left.)	Vigorous root-shoots.

				Nitrate of Potash.			
17	30″	2′	Split and nitrate poured in.	Dying. No shoots	Dead .	Quite dead ...	Dead.
18	21″	1′	Split and nitrate poured in.	1 shoot from ground level.	Poisoned part dead, shoots poor.	Killed to base, 2 weak root-shoots.	Weak root-shoots.
19	17″	3′	Nitrate placed on cut surface in pockets.	Ditto ...	Poisoned part killed, shoots vigorous.	Tip killed. Strong shoots.	Dead.
20	18″	1′	Ditto ...	6 new shoots from sides.	Poisoned part killed, shoots flourishing.	No real damage .	Strong root-shoots.
				Common Salt.			
21	30″ (a fork of 19).	In, and along grounds.	Split, and salt poured in.	Dying, split part dead, 1 shoot at ground level.	Poisoned part killed, root-shoots now appearing.	Killed to base, strong root-shoots.	Strong root-shoots.
22	27″	2½′	Ditto ...	Dying, 3 new shoots from 6″ below ground.	Poisoned part dead, shoots healthy.	Killed to base, weak root-shoots.	Dead.
23	32″	3′	Salt placed on cut surface in pockets.	Dying, 6 shoots from 6″ below ground.	Poisoned part killed, shoots stout and healthy.	Horizontal cut; no real damage.	Vigorous shoots.
24	17″ } 24″ }	..	Ditto ...	...	17″—dying—24″—numerous shoots arising this year.	Flourishing ...	Dead.

Serial No.	Girth of climber.	Height at which cut.	Method of application, 11-4-17.	Subsequent observations on 6-7-17.	17-7-18.	17-12-18.	10-5-20.
44	19"	1'	Cut horizontal and poured on.	5 new shoots ...	Many vigorous shoots.	Flourishing ...	Shoots alive.
45	23"	2'	Ditto ...	5 ditto ...	Ditto ..		Vigorous shoots.
46	24"	3'	Much salt ...	2 new shoots from 6" under ground	Ditto ...	Killed to base. Several stout shoots.	Dead root-shoots.
				Common Salt Strong Solution.			
27	22"	2½'	2 holes, 6" deep, bored with auger, and solution poured in.	Nothing, but stump still green.	Poisoned part killed, numerous shoots of this year	Killed to base. Weak root-shoots.	Strong shoots.
28	18"	2½'	Ditto ..	Ditto ...	Poisoned part killed, numerous shoots this year.	Killed to base, good root-shoots.	Vigorous.
				Permanganate of Potash Solution.			
25	37"	...	2 holes, 6" deep, bored with auger and solution put in.	1 very weak shoot, dying.	Dying ...	Quite dead ...	Dead.

26	18″ 36″	...	Ditto	4 new shoots from ground level	Poisoned part dead, shoots healthy	Killed to base, one weak root-shoot.	Weak shoots
42	16″	1′	Cut horizontal and poured on.	5 new shoots	Many shoots healthy.	Killed to base, strong root-shoots.	Alive and fairly vigorous.
43	24″	6″	Lightly sprinkled ..	2 new shoots ..	Dead; root-shoot sprouting.	Killed to base; one weak root-shoot, nearly dead.	Alive and vigorous.
				(Not a fair test, strong sap-lifter left.)			
				Sulphuric Acid.			
29	24″	2′	2 holes, 6″ deep, bored with auger, and solution poured on.	Dead, one shoot from 6″ below ground	Killed to base, several new root-shoots this year.	Several strong shoots	Strong root-shoots.
30	26″	...	Ditto	Ditto ..	Dying, but root-shoots sprouting.	Dead ...	Vigorous shoots.
31	36″	...	Cut horizontal and H_2SO_4 all over surface	...	Dead ...	Quite dead ...	Quite dead
				Mercuric Chloride.			
32	28″	2′	2 holes, 6″ deep, bored with auger and solution poured in.	2 new shoots at ground level.	Root-shoots ...	Not found ...	Root-shoot.
33	13″	3′	Ditto ..	Nothing ...	Poisoned part killed, many root-shoots this year.	Quite dead ...	Dead.

Serial No.	Girth of climber.	Height at which cut	Method of application, 11-4-17.	Subsequent observations on 6-7-17.	17-7-18.	17-12-18.	10-5-20.
34	21"	4'	Cut horizontal, and solution poured on	Nil ...	Dead ...	Dead	Dead.
				Sodium Arsenite.			
35	16"	1'	2 holes, 6" deep, bored with auger and poison poured in.	Nil ...	Poisoned part killed. Several shoots this year.	Killed to base Several root-shoots ..	
36	34"	1	Ditto	Nil ...	Not dead; hoots sprouting.	Killed to base; several vigorous root-shoots.	Dead.
37	28"	1'	Cut horizontal and poison poured on	2 new shoots at ground level.	Shoots vigorous ...	Killed to base; 2 weak shoots, nearly dead.	Do.
				Creosote.			
38	20"	2'	1 hole bored ...	2 new shoots ...	Shoots healthy	Killed to base; several root shoots.	Vigorous root-shoots
39	19"	1'	2 holes	Dead ...	Dead ...	Dead	Dead.
40	21"	1'	Cut horizontal and poison poured on.	Dying. 1 shoot at ground.	Dying, one root shoot sprouting.	Killed to base Several strong root shoots.	Do.
41	18"	1'	Ditto	Dying many shoots from 6" below ground.	Top dead; root-shoots sprouting.	Killed to base. Strong root-shoots.	Alive and vigorous.

S. H. HOWARD,
Silviculturist.

PROLIFIC GROWTH OF ROOT-SUCKERS IN *DALBERGIA LATIFOLIA*.

I enclose a photograph (frontispiece) of considerable interest as illustrating more clearly than I have ever seen it done before a fact which is, no doubt, well known to all forest officers who have had anything to do with Rosewood (*Dalbergia latifolia*). I refer to the prolific regeneration of this species by root-suckers.

The photograph was taken in an open field adjoining the reserved forest at the foot of the Anaimalais in South Coimbatore Division.

At certain times of year this forest is frequented by wild elephants.

Some ten years ago, as stated by the field chowkidar (watcher), the isolated rosewood tree was surrounded by a circular elephant trench. This trench is some 6 feet wide and 4 feet deep and its distance from the parent tree all round is 15 feet. It is designed to afford protection from elephants to the watcher who has a platform in the tree.

There are 26 root-suckers more or less evenly spaced and their age must be approximately ten years. With the exception of some half dozen shoots, which originate from the inner periphery or bottom of the trench, all the young trees have grown on the outer edge of the trench, *i.e.*, from the severed portions of the roots which are disconnected from the parent tree. Amongst the branches of the parent tree may be seen the field chowkidar's machan.

FURTHER EXPERIMENTS IN SALAI (*BOSWELLIA SERRATA*) TAPPING IN THE SHIRPUR EAST RANGE OF THE N. KHANDESH DIVISION.

On 23rd August 1917, I wrote a report on Salai tapping carried out in the N. Khandesh Forest Division from November 1916 to July 1917. Subsequently there was a demand for several cwt. of gum-oleo-resin for commercial tests, so the Range Forest Officer, Shirpur East, Mr. Bharucha, was instructed to tap sufficient Salai trees in his range on the old lines and to keep full details of

dates of tapping and yield, etc. He has kept accurate data and made some interesting observation which I will summarize:—

Girth of trees (inches).	No. of trees.	NET QUANTITY OF GUM COLLECTED (TOLAS). Decr. 1918.	Jan. 1919.	Feb 1919	Mar. 1919.	Apr. 1919.	May 1919 1–10.	Total collections (tolas).	Average total collection per tree (tolas).	REMARKS.
30″ 35″ ...	130	95	761	1,017	1,466	977	246	4,562	35·1	
36″–41″ ...	130	153	1,513	1,770	1,905	1,417	352	7,110	54·7	
42″–47″ ...	100	120	763	924	1 737	1,377	288	5,229	52·3	
48″ and above.	85	210	1,818	1,629	2,807	3,021	683	10,168	119 6	
Total tolas ...		578	4,875	5,340	7,915	6,792	1,569	27,069	60·8	1/3rd of month only.
No. of collections...		5	6	6	8	8	3	36	...	

2. The tapping was on a larger scale than that which was done two years previously and was therefore perhaps not so carefully done. Although the yield per tree is less than in the original experiment the new figures nevertheless very fully confirm that the best yield is obtained in the 4th month of tapping, after which exhaustion begins to set in. In this connection the Range Forest Officer points out that in order to meet his indent he had to commence tapping some extra trees on 9th March 1919, and that when tapping operations were closed down on 10th May these extra trees were still vigorously exuding gum-oleo-resin. This indicates that the yield is not so much dependent on the season as on the duration of the tapping operations. But, as before stated, the rainy season is a bad time for Salai tapping.

3. Mr. Bharucha further remarks that—

(*a*) trees with *green* bark yield more gum-oleo-resin than dry barked trees;

(*b*) trees with short boles yield less gum-oleo-resin than trees with long boles; and,

(*c*) the size of tree and nature of bark being the same, trees which are hollow yield a little more "drip" than sound trees, but that their yield declines earlier than that of sound trees.

THE EMPIRE TIMBER EXHIBITION.

BY ALEXANDER L. HOWARD,

The Overseas Trade Department of the Board of Trade some time ago conceived the idea of organizing an exhibition which should be a representative collection of those timbers which constitute the British Empire. This excellent scheme, possibly the direct outcome of the experiences of the war, was cordially and unanimously supported by the representatives of the Governments overseas.

Among the many lessons learned as a result of the war none was of greater importance than the knowledge that was brought home to us of our great dependence upon the products of the forest for the making and building up of every possible kind of offensive and defensive engine of warfare as well as for the maintenance of the daily requirements of ordinary life. From the time when the proposals of the Board of Trade were first considered, every effort was made by the representatives of the different States of the Empire and by the officials at Home to see that not a stone was left unturned to show conclusively what it was possible to achieve in the matter of timber production from every source. By a happy chance the date for the exhibition was fixed to coincide with that of the British

Empire Forestry Conference, which brought together representatives of the Forest Services throughout the Empire, and there can be no doubt that such an exhibition must form the best possible opportunity for the forest man to gauge the value of the work upon which he is engaged.

The countries of the world may be classed into three grades: one which possesses a competent scientific forest service with practical work in full operation; a second which also possesses such a forest system, but lacks the practical application of theory; and a third which possesses neither scientific nor practical forestry. It is regrettable that until a very recent date the United Kingdom must have been classed in the last category, and although much has been done in the past few years to remedy the situation, it is doubtful whether the great national importance of the subject has yet been fully realized.

The Empire Timber Exhibition entailed an enormous amount of continuous hard work and persistent energy which eventually resulted in bringing together a collection of many hundreds of timbers from every part of the Empire, and certainly the majority of those of any commercial importance. A collection of this kind is not easy to gather together, and it is doubtful whether such an opportunity is likely to be again available for a very long time.

The following are a few of the more noteworthy of the exhibits of the various countries:—

British East Africa.—The considerable forest resources of this country are practically unknown and their exploitation is yet in its infancy. The most important timber is pencil cedar (*Juniperus procera*), which is slightly harder and more brittle than the American variety (*J. virginiana*) So far it has not been much appreciated by British manufacturers, although its importance may be gauged from the fact that in 1910, 31,000 logs of this timber were imported into Germany from what was then German East Africa. As the majority of the lead pencils used in this country before the war were of German manufacture, the importance of this supply is obvious.

The Gold Coast.—Supplies of the timbers of the Gold Coast have already been seen in this country, but this exhibit showed many which are unknown here, though, as with other countries, much confusion arises from the varying vernacular names. The various species of Khaya, the African mahoganies, play the most important part, for this wood, which is generally of fine texture and good quality, has been in very large demand, and extraordinary prices have been realized for it. Another valuable wood is that labelled Odum (*Chlorophora excelsa*), which has also been imported as Iroko, sometimes falsely termed African Teak. While it is in itself of great value, and likely to be more so in the future, it possesses none of the qualities of teak with the exception of a superficial resemblance in colour. The wood labelled Kaku, also called Karkoo (*Lophira procera*), is generally known in England as African oak; it possesses unique qualities of strength and durability, and it is to be regretted that supplies seem to be scarce.

Nigeria.—From Nigeria also *Lophira procera* is available, though here it is known as Eki; it is a strong wood, and is reported as being both termite and teredo-proof. Other heavy constructional woods which resist the white-ant and show good promise for the future are Sasswood (*Erythrophlroeum guineense*), the gamboge-coloured Opepe (*Sarcocephalus esculentus*), Agboin (*Piptadenia africana*), and Apa (*Afzelia africana*). A particularly fine ebony of large size and beautifully variegated colour is that known as Kawraw (*Diospyros mespiliformis*). First and foremost amongst the woods from this region, however, are the mahoganies which form the bulk of the supplies. This exhibit was in charge of Mr. Lauchlan.

Western Australia.—The depletion of the forest in the past has reduced the volume of the timber available, but their re-afforestation is now in the charge of Mr. C. E. Lane-Poole, and supplies will probably be assured for the future. One of the chief factors in the great value of the timbers of Western Australia is their durability. Jarrah (*Eucalyptus diversicolor*) and Karri (*E. marginata*) sleepers, for instance, $4\frac{1}{2}$ inches by $9\frac{1}{2}$ inches, on

the Great Western Railway remained sound in the ground for twenty years, and appear to be good for another twenty years, while the trenail has remained in position during the whole period. It should be remembered also that a jarrah or karri sleeper 4½ inches by 9½ inches is better than one 5 inches by 10 inches of any other wood. Jarra is also shown in the form of flooring and provides a smooth, hard-wearing surface equal to that of any other hard wood. Telegraph arms in karri were exhibited, these have been extensively used and much appreciated by the G. P. O. for many years. These hard woods take premier place for such work as piling, wharf-planking, and bridge-building, and, though more costly in their initial outlay than many timbers, prove the most economical ultimately. As a furniture wood, jarrah is also excellent; the chairs, tables, and panelling which were exhibited illustrate its value for this purpose.

Canada.—At the Canadian exhibit, which was in the charge of Mr. Stokes, were shown two interesting models of wooden houses made of Douglas Fir (*Pseudotsuga Douglasii*). Some sixty-nine timbers were shown of which about twenty five are of commercial interest, the remainder forming a valuable reserve for future use. Two of the outstanding timbers are the Sitka or silver spruce (*Picea sitchensis*), which might be called the aluminium of timbers and veneer of brasswood (*Tilia americana*), which is used in the making of safety matches. The by-products of the Canadian forests include turpentine, artificial silk and surgical cotton made from sulphide pulp, and the ground wood-pulp which is used in the manufacture of the paper on which the *Daily Mail* is printed.

British Guiana.—The timbers produced from this country, the exhibit of which was in charge of Mr. Herbert Stone, are of very great importance, and provide a source of supply which has never yet been properly realized. With the exception of greenheart (*Nectandra Rodioei*), no import into the United Kingdom worth mentioning has occurred. This fact is evidence of the lack of enterprise which this country displays, because from Dutch Guiana (Surinam) similar woods have been known and appreciated for

many years in Holland, France, and Germany. Among the practically unknown timbers which should be in demand are purpleheart *(Copaifera pubiflora)*, the rich and brillant colour of which stands out remarkably even amongst the many brilliantly coloured woods of South America ; mora *(Diamorphandra Mora)*, a wonderfully durable wood suitable for constructional work and for sleepers ; wana *(Nectandra Wana)* ; brownheart *(Andira inermis)* (this wood, which is called Surinam teak by the Dutch, was named partridge wood by Laslett) ; locust *(Hymenoa courbaril)* : and crabwood *(Carapa guianensis)*. All these are fine durable woods suitable for construction in buildings which are required to last for generations.

Indian Empire.—The remarkable exhibit of the timbers of the Indian Empire, both in the raw state and manufactured into furniture and so forth, was the more noteworthy when it is remembered that practically none of these timbers of India had ever before been seen in this country. Even those who were acquainted with the forest wealth of India have not hitherto realized the extent of its commercial value in Europe. Among the exhibits were two halls and staircases made respectively in Indian silver greywood *(Terminalia bialata)* and Padauk *(Pterocarpus dalbergioides)* a dining-room panelled in gurjan *(Dipterocarpus turbinatus)* and furnished in laurel wood *(Terminalia tomentosa)*, a drawing-room in sissoo *(Dalbergia sissoo)*, a bed-room in Indian black walnut with panels of walnut burr *(Juglans regia)*, and a billiard-room furnished entirely in padauk and panelled in laurel wood. The great possibilities of the Indian timbers were, perhaps, most strikingly shown in the railway coach built by the Great Eastern Railway Company. The constructional portion was entirely of Indian wood, the decoration of the first-class carriage being in Indian silver greywood and that of the third-class in padauk. These presented such an excellent appearance that their increasing use in this direction is certain.

In addition to these larger exhibits were shown chairs, mirrors, and numerous small articles which serve to illustrate the many and varied uses to which the woods may be put. No trouble has been

spared to demonstrate the fact that for every purpose for which wood is required the products of the Indian forests can meet the demand. Some two hundred small specimens showed the wide range of colour and texture which is available. Among this large collection of timbers the following are particularly worthy of the most careful attention of those interested in timbers for decorative and constructional work. Gurjan *(Dipterocarpus turbinatus)*, a pale brown-coloured wood with a delicate aromatic scent, is an attractive medium for panelling, and one of the best hardwoods for flooring which it is possible to obtain. It is available in large sizes of superlative quality, and at a price which brings it within the range of even the most economical kinds of uses. Padauk is a wood which is unique in its brilliant red to maroon colour. It is exceedingly firm and durable, stands well without shrinking or warping, and is one of the strongest woods it is possible to obtain. During the war immense quantities of padauk were used for saddle-trees and gun-carriages, for which purposes it is difficult to find its equal. It was also used for the felloes of some exceptionally large wheels for heavy guns for use in Russia. The produce of a species of Canarium, which has been termed Indian white mahogany, is likely to take an important place in the future. It is a smooth, even grained wood which will be available at a very reasonable price. Haldu *(Adina cordifolia)* is a bright canary-coloured wood notable for the smooth and even regularity of the grain. It is possible to carve it in any direction without splitting, a striking quality which gives it a particular value. Perhaps the finest carving wood which it is possible to obtain, however, is Indian red pear *(Bursera serrata)* which possesses the above qualities in a unique degree. Other woods which are chiefly notable for their decorative qualities are Indian red zebra-wood *(Melanorrhœa usitata)*, Indian primavêra, yellow-heart *(Fagraea fragrans)*, and the handsome striped and mottled ebony known as Andaman marblewood *(Diospyros Kurzii)*. It becomes abundantly clear that the only thing necessary for these timbers of India to take the important position which their merits deserve is that the representatives of the Government in India should continue to

provide regular and certain supplies, and to this end extensive arrangements are now being made.

The United Kingdom.—About seventy varieties of timbers grown in the United Kingdom were shown, and these included such importations as the silver wattle of Australia and the black walnut *(Juglans nigra)* of America. Floorings in yew *(Taxus bacata)*, cherry *(Prunus Avium)*, and beech *(Fagus sylvatica)*, amongst others, illustrated a little-known use for these woods. The decorative effect of English brown oak *(Quercus Robur)* was shown in various articles. Other exhibits, such as the gondola of an aeroplane made in English ash *(Fraxinus excelsior)*, called to mind the large part played in the war by the native timbers.

Other countries showing interesting exhibits, of which space forbids mention, were British Honduras, Ceylon, Fiji, Newfoundland, New South Wales, New Zealand, Union of South Africa, Tasmania and Trinidad.—[*Nature.*]

On July 21st the King received at Buckingham Palace the principal members of the British Empire Forestry Conference, which sat in London during the preceding fortnight. The members included delegates from Great Britain and Ireland, India*, and the various Dominions and Colonies. Lord Lovat, president of the conference and chairman of the Forestry Commission of the United Kingdom, presented the delgates separately to His Majesty; and Mr. H. R. Mackay, Forest Commissioner, Victoria, and representative of the Commonwealth of Australia, read an address to the King, who in his reply congratulated the Home Forest Authority on its joining hands so soon with foresters in other parts of the Empire. He referred to the work of universities and colleges and to the experience gained in the Crown woods and private plantations as having laid a foundation on which it is incumbent to build. The King pointed out the peculiar difficulty of forestry work, which demands, perhaps, more imagination, more patience, and more foresight than any other industry, and considered

* The Indian delegates were Messrs. Clutterbuck, Perrée Troup and Gibson, and Sir William Schlich represented Oxford University.

it an immense advantage that the experience of all parts of the Empire should be brought into a common stock and made available for all. Forestry, directed as it is to checking reckless consumption of the world's supply of timber and to teaching and encouraging thrifty use and prudent replacements, represents a great work for the common good. The conference will result both in practical improvements in the operations of the Forestry Services at home and overseas, and in a truer and wider appreciation of their value to the Empire at large.—[*Nature*]

THE USE OF AIRCRAFT IN FORESTRY.

Often, in years gone by, when trying to make maps of the immense tracts of forest land in Canada with the thermometer at 50 below zero or the black flies and mosquitoes eating one alive, the writer wished for a balloon. The labour required to get supplies into the woods, the hardship to be overcome the toil required to map a few square miles of rough, heavily timbered country and the amounts expended seemed so out of proportion to the results obtained. One party of ten men used to do 50 square miles a month at a cost of about fifteen to sixteen dollars per square mile, and we mapped 2,800 square miles. Then the timber estimates had to be made, which involved tramping through the woods, calipering and estimating the trees and trying to find accurately the dividing lines between types.

Now the dream has come true and in Canada with its myriad lakes the flying boat, equipped with the Eastman K-1 aerial camera, just a glorified motor-driven "kodak," is doing in hours what it took months to do on the ground.

Thanks to the generosity and broad-mindedness of the Minister of Naval Affairs, Mr. C. C. Ballantyne, who loaned two H. S. 2 L. flying boats and the Hon. Jules Allard, Ex-Minister of Lands and Forests of Quebec, and the St. Maurice Forest Protective Association, who together subscribed $12,000 for the work, the writer was enabled to try experiments in spotting forest fires and making photographic maps of the forest.

The two seaplanes were assembled at the Station at Halifax and flown across Nova Scotia, New Brunswick and Northern Maine to Lac a la Tortue, Quebec, by Lieutenant Stuart Graham, of the British Navy. These two trips of 750 miles each were made without any mishap whatever.

It was wonderful, in flying over a wooded country, to see how easily the boundaries of the various timber types could be traced and by taking a map into the air, the various types, the approximate size and density of the timber could be easily sketched on it, and that, too, much more accurately than from a ground reconnaissance. One afternoon, flying over a tract of fifty square miles which had been carefully mapped a few years before, I found a small lake which had not been located by the field party, and although I had often been over the tracts on foot I brought back more information in the hour I was over the tract than I had previously gathered. In flying over a tract which we contemplated purchasing, we were able in one afternoon to see that it did not contain enough timber to warrant paying the price asked for.

The different species of trees shown up with remarkable clearness from the air and the topography, camps, roads and trails can be seen, and the shallows in the lakes and rivers can be picked out. Logs left in the rivers and lakes by the drives of the previous year can be readily seen and photographed and if the number in a unit area on a photograph are counted and the area measured with a planimeter, a much closer estimate of the number in any body of water can be obtained than by having a man look at them from the shore and guess.

It is the intention, during the coming season, to take bi-weekly aerial photographs of the log drives so that it can be seen at once what progress has been made and whether the rivers have been swept clean. By noting the points where the logs jam and stick it will be possible to make plans for the removal of obstructions, the building of piers and other river improvements.

Photographs are taken at the speed of about sixty miles an hour, which means about one hundred pictures in that time

covering forty-five square miles—about as much country mapped in one hour as a crew of men will do in a month and with much more detail and accuracy and giving at the same time, directly from the picture, the areas of lakes, of burns, of swamps and of the different types of timber. The cost of the aerial work, too, is only about one-tenth of that of the ground work. The photographs are eight by ten inches and the best altitude for this work is about five thousand feet, which gives a scale of 400 feet to the inch.

We have a party in the woods now studying the interpretation of the forest photographs and have already found that we can draw the boundaries of the timber types with great accuracy, and that in many cases we can draw contours. Individual trees in the photographs can be easily located and species can be distinguished. We are now studying areas which seem to be typical on the photographs, calipering every tree which enters the crown cover and getting the number of trees of each species and their heights. When this work is finished we shall have a reliable legend for reading the photographs. We have another party studying photographs taken over brush and farm lands which it is proposed to buy for reforestation and find this photographic work of the greatest value. Building lot lines, cleared lands, swamp, brush, roads, fences, stump land and drainage ditches all show up with remarkable clearness, and photographs are most useful in buying the land as they give more information than the owner has himself.

For making maps and estimates of the enormous areas in eastern Canada which have not yet been surveyed, aerial work will prove of the greatest value and will make it possible to secure in a very few years information about the timber lands so sorely needed and which cannot be had in any other way except at a prohibitive cost and after many years of labour. It is proposed during the coming season to cover from three to four thousand square miles of territory and if other companies which are contemplating similar work carry out their programme a very large area will be covered by the end of the summer. Aerial work will also

prove of value in studying the problems of water storage for power and irrigation projects and for the location of new railway lines and cut-offs for existing lines. The aeroplanes will also be of value in logging operations, enabling the superintendent to make more frequent trips to his operations and to keep in closer touch with his men. Then in case of accidents in the woods, the injured can be brought out without delay.

Aerial work is bound to be of great use in many ways in the near future, but I venture to say that in no department will it prove of more value than in forestry, especially in giving what is so sorely needed, a sufficiently accurate inventory of forest resources in a reasonable length of time and at a reasonable cost. It will do away with much of the drudgery and monotony of forest reconnaissance.—[ELLWOOD WILSON in *American Forestry.*]

THE QUEST FOR PENCIL WOOD.

A nation wide search for pencil wood is on. The famous red cedar of Tennessee is nearing exhaustion, according to the pencil manufacturers, and what remains of this once important stand is situated in the depths of remote swamps, where negro labourers are wading through water and mud up to their waists to coax out the comparatively few remaining trees, after the fashion of mahogany logging in darkest Africa.

Pencil users are temperamental and the pencil factories dare not risk their good reputations on untried woods. If when John Brown buys a pencil, and forthwith essays to bring it to a delicate point with his trusty penknife, his blade shies off at an angle and breaks the lead, he consigns that particular brand, together with its makers, heirs and assigns to eternal perdition.

The pencil factories of the United States and Europe are looking to the Pacific Coast for further supplies of wood. Up to the present time only one really satisfactory wood has been found in sufficient quantities in this section, this being the incense cedar of California and Southern Oregon. This tree is frequently afflicted with cell rot, rendering a large portion of its volume unfit for pencil manufacture. In fact the waste in the working of

this wood for pencil slats is close to 40 per cent. The supply of this valuable wood is far from being inexhaustible and scouts for the pencil interest are almost constantly in the field looking for substitutes.

Juniper from the Central Oregon country is now having its trial as a pencil wood. Slat manufacturers say that it is the finest wood in the world for pencil making. The supply is large and the problem sounds as though it were solved. Juniper unfortunately is like incense cedar, "only more so." One must consider himself fortunate to find a layer of sound wood under the bark that measures in depth much over four or five inches. The remainder of the trunk is almost invariably rotten. Juniper may also have limbs extending clear to the ground, from which clear sections for pencil making are none too bountiful The waste in cutting up juniper for pencil slats is therefore even higher than in the case of incense cedar, in some cases amounting to as high as 75 per cent. of the total volume of the wood being sawed.

What material that can be obtained from juniper is without a peer in the pencil world, but the success of the industry depends upon how low the margin of waste can be held. Juniper whittles to perfection and the grain is close and the fibres short.

Some one asks, why not use redwood? It sounds plausible and some really first-class pencils have been made from this wood. The "nigger in the woodpile" in this case is the fact that no less than seventeen degrees of hardness of grain have been found in one redwood tree. Portions of the logs have yielded superior slats, especially the sapwood immediately under the bark. How to make arrangements to secure nothing but redwood sapwood is one problem that the pencil industry is not ready to solve. To illustrate what good stock can be secured from redwood, a pencil scout told of receiving a bundle of samples from an eastern factory, asking why they could not have a shipment of wood like that in the samples, which they stated was redwood. The wood was redwood without question and the pencils were of the very finest quality. It developed however that the wood was specially selected in Del Norte country from the sapwood of a

choice redwood log of large dimensions. What became of the remainder of the carcass was not mentioned. Redwood has not yet been despaired of by the pencil people and further experiments are being made.

Coming up the coast from California, one finds two cedars, one a true cedar and the other in reality a cypress. These are the western red cedar of Oregon, Washington and British Columbia, and the Port Orford or white cedar of Coos and Curry counties in south-western Oregon. Both of these woods have had trials by the pencil factories, with no great success. Port Orford cedar has been found a trifle too hard and red cedar as a rule too coarse. Red cedar has not yet been relegated to the category of the impossible and further tests of this wood are to be undertaken.

The pines of the West have been found unsuitable, declare the pencil interests, because of the pitch pockets.

Idaho white pine is yet to be tried and there is thought to be some hope for this wood. California sugar pine has been found *suitable for penholders and some of this wood goes into this stock*, but the total volume of the penholder business is insignificant compared with the pencil industry.

Other woods tried and found wanting are red alder and the so-called yellow cedar of Alaska. These were discovered to be too hard.

Thus we exhaust the pencil wood possibilities of the Pacific Coast. So far the choice resolves itself to incense cedar and juniper.

But the dearth of pencil wood may be solved in some other way. Among the several pencil wood scouts who have sought advice from this office as to where to hunt for fresh sources of supply, we have failed to discover one who uses a wooden pencil. Their notes are invariably made with that twin brother of the India-rubber fountain pen—the new-style metal pencil. Perhaps this is the ultimate solution to the pencil wood problem.—

[*The Timberman*, Vol. XXI, No. 9.]

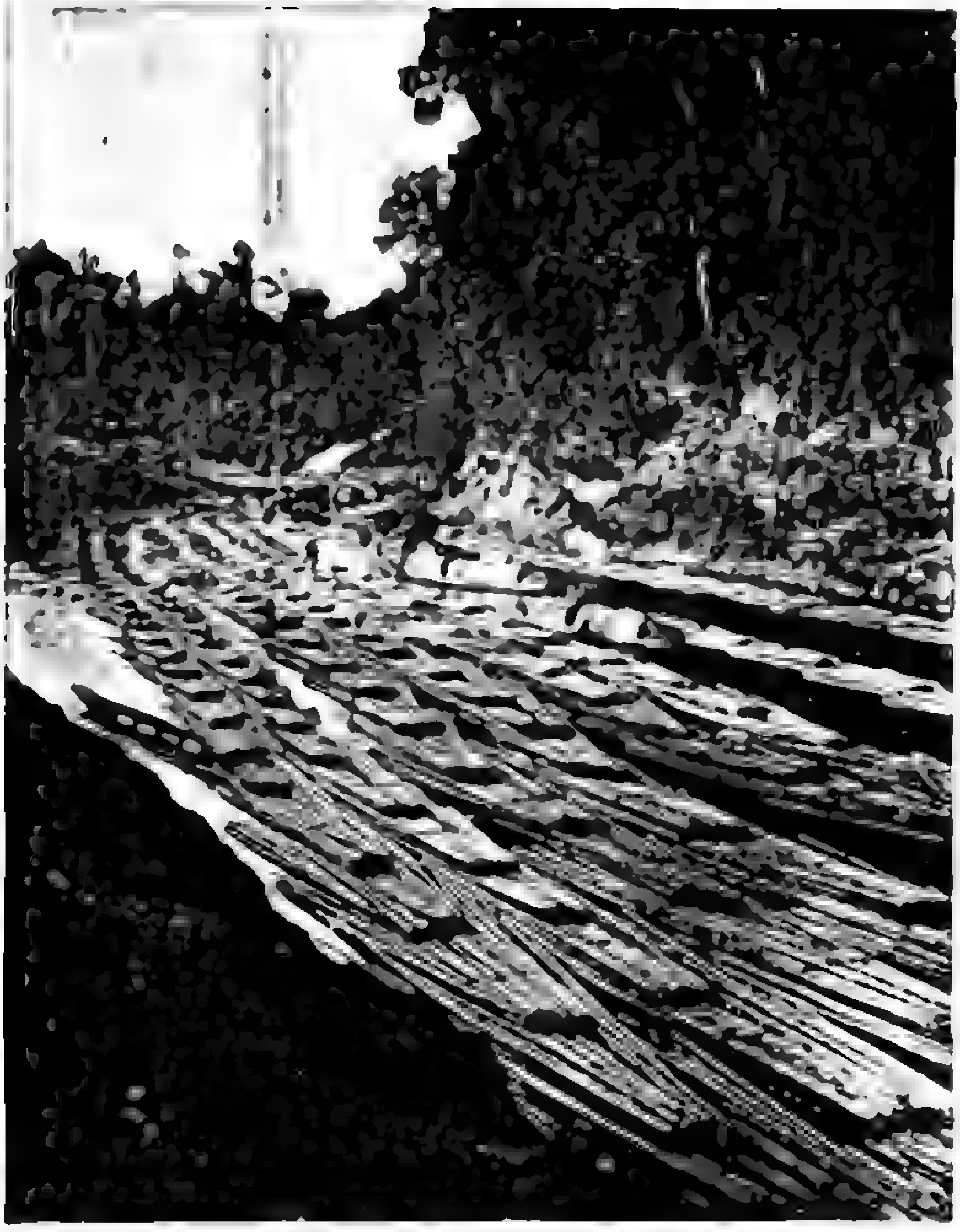

Photo Mech. Dept, Thomason College, Roorkee.

Photo by R. S. Pearson,

Bamboo rafts at Mainmuk Kassalong river, Chittagong Hill tract.

VOLUME XLVI NUMBER 12

INDIAN FORESTER

DECEMBER, 1920

THE UTILIZATION OF BAMBOO FOR THE MANUFACTURE OF PAPER-PULP.

BY R. S. PEARSON, C.I.E., FOREST ECONOMIST.

(Continued.)

In Volume IV, Part V, of Indian Forest Records, 1912, which was reprinted in 1916, detailed descriptions are given of five bamboo areas in Burma, three in Bombay and three in Madras Since then several other areas have been inspected, two of which have already been leased for the extraction of bamboos for the manufacture of pulp, and are therefore not mentioned in this note. Moreover, at the time of writing the original record, certain information which had been collected was omitted as it was thought that during the initial stages of the enquiry it was not necessary to describe more than a few localities. Now that enquiries are frequently made for suitable areas from which to extract bamboos, it seems necessary to place on record what further information is available on the subject.

I.—Bamboo Areas in Burma.

(1) *The Bhamo Area.*

In 1910 Mr. Cubitt, who was then Deputy Conservator of Forests in Bhamo, and is now Conservator in the Strait Settlements, submitted a detailed report on the subject of extraction of bamboos for pulp from his division, of which the following is a summary :—

The species of bamboo found in those forests are *Dendrocalamus membranaceus*, "Wapya" or "Wagé," *Dendrocalamus Hamiltonii*, "Wabomyetsangyè," and *Cephalostachyum pergracile* "Tinwa," of which large quantities can be extracted annually without either detriment to the forest or an appreciable increase in price.

The scheme put forward is based on the assumption that unbleached pulp will be manufactured in Upper Burma and that it will be exported to Rangoon or elsewhere to be converted into paper. Three sites are suggested for a factory, either at Katha, Tagaung or Mandalay. Were Katha selected it would tap the whole of the Bhamo Forest Division and small portions of the Ruby Mine and Katha Divisions, while the factory would have both rail and river communication with Rangoon. The Tagaung site has an advantage over that at Katha, in that it would tap the Shweli and Méza drainages, from which millions of bamboos are extracted annually, while the cost of landing them from the Bhamo district would not be much greater to Tagaung than from Katha. The drawback, if it may be called so, is that there is only steamer and not rail communication with Rangoon. Mandalay is rather far from Bhamo for the regular extraction of raw material, on the other hand large quantities of bamboos are available, which have been used for floating timber and which can be obtained at very low prices, and this supply would help largely towards the total quantity required to run a pulp mill. The supply could be further augmented by supplies of bamboo from the Madaya drainage, although the lower reaches of the river are canalized for irrigation, and road transport for some 20 miles would have

to be employed. The drainage area of the Madaya is approximately 500 square miles.

The cost of landing a ton of air-dried bamboos at the factory site is put at Rs. 10, based on weights given by Mr. Sindall and presuming that very rigid selection is not enforced, which for the manufacture of paper pulp is not necessary. The figure arrived at by Mr. Cubitt is very approximately the same as that arrived at by the writer for areas inspected in Lower Burma. Allowing for increase in wages since that estimate was framed, it is probable that it will not cost more than Rs. 15 to land a ton of air-dried bamboos at the factory.

Labour is expensive in Burma, Mr. Cubitt puts it at Rs. 15 per month, it would probably be double that at the present time. Fuel is plentiful and is put at Rs. 7 per 100 c.ft. which figure would also require modifying under present conditions. Lime is available in quantity about 40 miles below Bhamo. Water is also abundant but it would require to pass through filter-beds before use.

(2) *Bamboo Areas in Arakan.*

The writer inspected the Seik catchment area, a tributary of the Mayu, with Mr. Walker, the Divisional Forest Officer, Arakan, and a description of this area is given in Indian Forest Records, Vol. IV, Part V, pp. 66—75.

The Seik is a relatively small river when compared with others in Arakan and the only reason for selecting this area was that a fine waterfall occurs some 60 miles up its course, where a plentifull supply of fresh water is available. From the point of view of extraction of bamboos for paper-pulp, the forests may be divided into the following catchment areas, information about which has been supplied by Mr. Walker, after personal inspection :—

(*i*) *The main Mayu river.*—The hills are some distance from the stream and the area is covered with a large variety of evergreen trees and bamboos. On the whole it is not thought to be an ideal area for the extraction of bamboos.

(*ii*) *The Seik Chaung drainage* has been described, it contains 380 square miles of forest, and is probably the best area in the division.

(*iii*) *The Tawbya Chaung* is a feeder of the Mayu river, and contains three waterfalls, which with the rocky state of the bed of the river make the extraction of bamboos more difficult, though by no means impossible, as fair quantities of bamboos are at present extracted for house building. The area of this catchment is 410 square miles.

(*iv*) *The Pi Chaung drainage* is a distinctly good area from which to extract bamboos, though at present no large quantities are exploited. The area of this catchment is 350 square miles.

(*v*) *The Mi Chaung drainage* is 180 square miles and is one of the principal sources of supply for Akyab.

(*vi*) *The Kaladan drainage* covers some 430 square miles and is one of the largest in the district, it is an excellent area from which to extract bamboos, though comparatively heavily cut for taungyas or shifting cultivation.

(*vii*) *Daywè Chaung and feeders* tap an area of 380 square miles, covered with bamboos, from which large supplies are drawn for local consumption, it is thought, however, that the quantity extracted only forms a fraction of the possible annual yield.

(*viii*) *Than Chaung drainage* covers 480 square miles, well stocked with bamboos, and sufficient to support a large mill.

(*ix*) *The Lemru* main stream catchment area, covering 500 square miles, with very few villages between Pengwa and Hun, is an area which might well be reserved for the extraction of bamboos for paper-pulp.

(*x*) *The Dalet Chaung drainage* has a large stream and is thought to be a promising area for the extraction of bamboo, though not actually inspected by Mr. Walker.

(*vi*) *The To Chaung*, which flows into the sea at *Kyaukpyu*, is a good stream, though possibly the area is on the small side and hardly sufficient to support a factory.

From what has been said above it will be readily understood that the areas covered with bamboos in Arakan are very extensive, and sufficient to support several pulp mills. To picture in one's mind the quantity of bamboo forests is hardly possible without actually visiting the areas. The rivers flow practically north and south and closely parallel to each other and between them run low narrow ridges some 300 feet above sea level. By climbing to the top of any one such ridge as far as the eye can see is ridge upon ridge densely covered with bamboo forest often presenting a chess-board appearance due to successive fellings by taungya-cutters.

The bamboo found in these forests is different from most other species in that it does not form clumps but grows by single stems from the rhyzomes, thus forming dense uniform masses of growth. Its local name is "Kayin" (*Melocanna bambusoides*), in other localities more commonly known as "Muli," a thin-walled bamboo, which is easy to cut and also dries quickly. It flowered all over the district in 1911—13 and as it only flowers every 30—35 years, there is no danger of a shortage of bamboo in Arakan for many years to come.

A more difficult problem is that of taungya-cutting, which goes on practically all over the area and has done so for many generations. The system is described in a section of the Forest Record dealing with the Seik Chaung and need not be repeated; it is sufficient to say that unless an area can be reserved and the taungya-cutters accommodated elsewhere, there is no chance of working the area for bamboos for a pulp mill.

The other point which will need careful investigation in connection with any one of the above-mentioned areas is that of the fresh water supply, as the rivers are generally tidal for a considerable distance up their course. Enough has probably been

said to demonstrate the great possibilities of the Arakan forests in connection with bamboo for the manufacture of pulp and to indicate to interested parties where to look for bamboos.

II.—BAMBOO AREAS IN INDIA.

1. *Note on the Porahat Forest Division in the Singhbhum District of the Province of Bihar and Orissa*

(This note has been supplied by Mr. Makins, I.F.S., formerly in charge of the Porahat Division.)

The Porahat Forest Division in the Singhbhum district of the province of Bihar and Orissa, contains 196 square miles of reserved forest of which over 50 square miles are densely stocked with the bamboo, *Dendrocalamus strictus*. The same species occurs sporadically over the whole of the remaining area. The culms are large and tall. The outturn per acre should compare favourably with that of any other bamboo area in India. A distinct advantage is that the best bamboo areas are concentrated in one place, the Kundrugutu block, partly overlapping into the Bera and Sorrgea blocks on either side. The Girga block not included in the above 50 square miles is also very rich in bamboos but is somewhat remote from the other blocks. At present between 3 and 4 lakhs of bamboos are sold annually on permits at a royalty varying from eight annas to four annas per hundred according to quantity but the best areas are still practically unexploited.

Sabai grass (*Ischæmum angustifolium*) occurs throughout the area which is leased to a Calcutta firm for three years. The fact that both bamboo and Sabai grass are found in the same locality should considerably increase its value for the manufacture of paper-pulp.

There are no large rivers suitable for floating but numerous small streams contain water all the year round.

The average distance from the railway is only 20 miles. A system of excellently graded cart roads constructed and maintained by the Forest Department serves all parts of the forests,

The Public Works Department metalled road from Chakardharpur railway station to Ranchi traverses the north-eastern portion of the tract.

Produce is exported along these roads to Goilkera, Sonua, Lotapahar and Chakardharpur railway stations, all of which are on the Bengal-Nagpur Railway main line from Calcutta to Bombay. Sonua is probably the most convenient point on the line for the greater part of the bamboo area, the distance from Calcutta by rail being only 207 miles.

The district is undergoing remarkable developments owing to the recent discovery of enormous deposits of iron ore, besides chromite, manganese, silver, gold, kaolin, limestone, ochre and other minerals. The result is that a backward jungle tract is being rapidly transformed into a busy industrial centre. Singhbhum is the future "Black Country" of India.

Labour is cheap and plentiful, the district being one of the chief recruiting grounds for the Assam tea gardens. The following extract is taken from the revised working plan of the Porahat reserved forest, 1920:—

"Labour for forest works is obtained almost entirely from the local villages. The present rate of wages for daily labour is three annas six pies for men, two annas six pies for women and two annas for children. Railway, mining and other industrial enterprises have drawn away a certain amount of labour from the forests, but the local coolie, if he can obtain a living wage near his home, is not attracted by the higher rates offered further afield. In times of scarcity thousands of coolies emigrate to the Assam tea gardens chiefly from the open parts of the district. Forests tracts are hardly affected as distress there is never so acute."

2. *The Bamboo Areas of the Borak and Kata Khal Catchments in the Cachar Division of Assam.*

In March 1912 the writer visited Assam with a view of selecting, if possible, areas from which bamboos could be extracted for the manufacture of paper-pulp, and the following note was prepared on the subject:—

(2) *The Bamboo Areas of the Borak and Kata Khal Catchments of the Cachar Division in Assam.*

1. *Name and situation.*—The bamboo areas comprised in the Borak catchment area are the Upper and Lower Jiri, the Borak, the Sonai, and Inner Line Reserves in British territory and the western slopes of the Manipur Hill Tract. To these must be added a certain area of unclassified forest in the upper reaches of the Jiri river, a tributary of the Borak river of which the acreage is uncertain, but which is not less than 20,000 acres.

The bamboo areas of the Kata Khal catchment area comprise a portion of the Inner Line and Kata Khal Reserves and a portion of the unclassed forest on the western slopes above the river.

2. *Description of the Forests. General.*—The forests are everywhere of a moist deciduous to evergreen type, by far the greater portion being of the latter class. They contain a great variety of different species of trees, many canes in the heavy evergreens and bamboos, the latter, however, are by no means found all over the area. In the dense evergreens no bamboos occur, while in certain areas few trees are present and practically the whole growth is of bamboos

Such areas are generally "old jhums" or areas over which shifting cultivation has taken place. Owing to the irregular distribution of the bamboos and more especially owing to want of time, it was found quite impossible to locate accurately all the bamboo yielding areas. All that it was possible to do was to inspect some of the forests, such as the Upper and Lower Jiri and Borak Reserves and a small portion of the Manipur forests on the east bank of the Jiri river, and to collect all possible information from the Forest Officers and other local inhabitants who are well acquainted with these forests. The Borak and Jiri rivers were also inspected for a distance of about 48 miles above Silchar in order to ascertain their suitability for floating purposes.

1ST AREA.—*The Borak Catchment Area.*

The Upper Jiri Reserve.—Bamboos occur on the north-western side and again on the low hills in the centre of the block. A certain number are to be found along the east bank near the Jiri

river. The rest of the block contains dense evergreens with many canes but no bamboos.

Lower Jiri Reserve.—Bamboos occur in the north, west and south-west, towards the tea garden of Alnee and again in the south in the corner formed by the junctions of the Jiri and Borak rivers, while the north-east portion is dense evergreen forest with few or no bamboos.

The Borak Reserve.—This is a large block of forests draining into the Borak river from a point where it turns due south at Naraindhar and reaching up to Mynadhar, where it adjoins the Inner Line Reserve, which is a continuation of these forests but bearing another name. Above the Naraindhar tea estate and along the river are old deserted tea gardens. The slopes are covered with evergreen and bamboo forests. Up the ravines and all along the upper slope in the neighbourhood of Naraindhar, large plantations of bamboos occur, the clumps being often of great size; higher up the river towards Mynadhar the bamboos become even more plentiful, while on passing into the Inner Line Reserve, especially towards Tepai Mukh, the slopes are nearly entirely clothed with bamboo growth.

The central portion of Inner Line and Sonai Reserves.—The Inner Line Reserve is, as stated above, drained on the east by the Borak, that is towards Tepai Mukh. The greater portion is, however, drained by the Sonai and its tributaries the Rukni and Punikai, the Sonai eventually flowing into the Borak at Sonai Mukh. These areas contain bamboo forests mixed with evergreens from which considerable quantities of bamboos are extracted annually. The western part is tapped by feeders of the Kata Khal river and will be discussed later.

The Manipur Forests.—These forests were not inspected, except a portion opposite Badkhal on the Jiri river. They are said to contain large areas of bamboos, especially in the upper reaches of the Jiri and again from Mognadhar southwards on the Borak.

Unclassed Forests.—These are generally old "jhumed" lands of which a considerable area occurs between the Upper and Lower Jiri reserves and again to the north of the former reserve.

2ND AREA.—*The Kata Khal Catchment Area.*

1. *Western portion of Inner Line Reserve.*—The area is tapped by the Baruncherra, a tributary of the Kata Khal or otherwise known as the Dallesar river. The country is in many places difficult, so that bamboos could only be exploited from near the river or its tributaries. Many bamboos also occur on the west bank of the Dallesar both in the Inner Line Reserve and in the unclassed forest north of the reserve.

2. *Kata Khal Reserve.* The Kata Khal Reserve lies on the east bank of the river of that name and is chiefly tapped by its tributaries the Dalacherra, Guglacherra and Rupacherra. There is a good deal of bamboo forest mixed with evergreen in this reserve, and the country is not so difficult as that to the south in the Inner Line Reserve.

3. *Area of the Forests.*—It is impossible to state with accuracy the area of forest containing bamboos, as all the forests could not be examined for want of time, the computation has for safety's sake been put at a very low figure.

Catchment area.	Name of Reserve	Total area of forests, in acres	Approximate areas from which bamboos can be exploited, in [illegible].
1	2	3	4
1st Area. Borak and Sonai Catchment areas.	Upper Jiri Reserve ...	15,360	7,000
	Lower Jiri Reserve ...	9,002	6,000
	Borak Reserve .	14,230	20,000
	Inner Line Reserve (Eastern portion).	41,010*	15,000
	Inner Line Reserve (Central portion).	1,00,000*	30,000
	Sonai Reserve .	13,453	8,000
	Portion of Manipur forests.	50,000 (estimated).	15,000
	Unclassed forests ...	2[illegible],000 (estimated).	10,000

* NOTE.—The whole of the Eastern, Central and Western portions of the Inner Line Reserve, together with the Kata Khal Reserve, contain 2,41,010 acres.

Catchment area.	Name of Reserve.	Total area of forests, in acres.	Approximate areas from which bamboos can be exploited, in acres.
1	2	3	4
2nd Area. Kata Khal Catchment area.	Inner Line Reserve (Western portion).	1,00,000*	20,000
	Kata Khal Reserve ...	1,00,000	25,000
	Unclassed forests (North of Inner Line Reserve)	20,000	8,000
	Total ...	5,13,055	1,64,000

The figures for the acreage from which bamboos can be exploited have been put very low as compared with the total area of the forest because either much of the forest is of a dense evergreen character, or the bamboos are difficult to exploit, as for example from the higher slopes of the hills in the upper reaches of the Borak and from the difficult country to the south of the Inner Line and Kata Khal Reserves.

4. *Species of Bamboos and mode of growth.*—The prevailing species are *Melocanna bambusoides*, known locally as the "Muli" bamboo, and *Teinostachyum Dullooa*, the "Dollu" bamboo. The former is the same species as that which prevails in Arakan, Chittagong and parts of Burma proper. This species grows by single stems and not in clumps, is a thornless, moderate-sized bamboo, and is easily extracted. The average of ten cut culms gave a length of 29·8 feet and a mid-girth of 7·45 inches. The internode walls are relatively thin and light and the node small. This species of bamboo is stated by Brandis as probably flowering every 30 or 35 years but that further information is required before these figures can be confirmed. In any case it is certain that it flowered in 1910–12 over large areas in the Cachar Division, for the dead bamboos are now standing all over the forests, while those which did not flower last year have been found in full flower this year. This would appear to stop all possible chance of extracting bamboos for

paper-pulp from this area for the next four or five years to come until the bamboos have grown up again.* On the other hand the bamboos having flowered is a distinct advantage, inasmuch as it ensures that they will not do so again for at least 30 or 35 years. The new bamboos can now be seen coming up everywhere.

The other common bamboo is *Teinostachyum Dulloa* growing in fairly open clumps, thornless, with average to thick walls and thin nodes. The average length of ten cut stems was found to be 30·9 feet, with an average mid-girth of 7·8 inches. Several other bamboos occur such as *Bambusa Balcooa*, known locally as "Balku" or "Baluka," also *Dendrocalamus Hamiltonii* called "Pecha," a very large bamboo, found in the Borak Reserve; none of these are taken into consideration in this scheme as they are not found in sufficient abundance to justify their inclusion.

5. *Possible factory site.*—There appears to be little doubt that the factory site should be fixed at Badarpur or somewhere near there, for the reason that all the main rivers by which the bamboo forests are drained converge on that place, besides which it is the point where the Assam-Bengal Railway crosses the Borak river. It should here be mentioned that this river is called the Borak at Badarpur but lower down towards its junction with the Brahmaputra it is called the Surma river. The distance of Badarpur from the Upper Jiri Reserve, one of the furthest reserves from the proposed factory site, is 103 miles by river and 45 miles by road. The distance by river is made up as follows:—from Badarpur to Silchar, 40 miles; from Silchar to Lakhipur, 37 miles; Lakhipur to Upper Jiri Reserve, 26 miles. The Lower Jiri and Borak Reserve are lower down the Borak river, while the Inner Line and Kata Khal Reserves are about the same distance from Badarpur as the Upper Jiri Reserve, though drained by the Sonai and Kata Khal rivers and not by the Borak.

The advantage of placing the factory at Badarpur has been stated above as being due to the fact that it is situated below the point at which the Soni and Kata Khal rivers flow into the

Note.—This inspection was made in 1912.

Borak river and also that it is on the Assam-Bengal Railway. Further, river steamers come up to Badarpur in the rains, establishing direct communication with Calcutta by river, while large country boats ply up and down the river throughout the year. These conditions establish a cheap means of importing the necessary chemicals and of floating down the raw materials to the factory and of exporting the pulp to Calcutta.

6. *Outturn.*—A large number of bamboos are exploited annually by traders and private persons, thus in 1910-11, 9,39,925 bamboos were exploited from the reserved forests and 10,37,775 from the unclassed forests of the Cachar Division or roughly two million bamboos annually.

The possible annual outturn depends on three factors, namely —(*i*) the area of the forests from which bamboos can be exploited, which is given in section 3 as 1,64,000 acres; (*ii*) the density of the crop, the estimate of which is based on the figures obtained by taking sample plots (see Appendix (I), and (*iii*) the rotation of cutting. Headings (*i*) and *ii*) have already been discussed, it remains to fix a possible rotation according to which felling should be made. In Burma the rotation on which *Cephalostachyum pergracile* and *Bambusa polymorpha* are to be extracted has been fixed at five years, and in Arakan for *Melocanna bambusoides* a seven years' rotation has been prescribed. In the Cachar Division we are dealing with the latter species and a new one, *Teinostachyum Dullooa*. From Appendix I it will be seen that the proportion of new to old "Dollu" culms is roughly as one is to four. The rotation might therefore be fixed at five years; for safety's sake it may be put at seven years, so as to bring it in line with that for *Melocanna bambusoides*.

The only other point to be considered is the proportion of "Muli" to "Dollu" bamboos in the forest. The area covered by the latter is greater than that covered by the former, on the other hand there is by weight just double the amount of "Muli" to "Dollu" per acre. It has therefore been taken that the amount (by weight) obtainable of each is about equal.

From Appendix I it will be seen that there are on an average 23·5 tons per acre. The area of forests as given in section 5, from which bamboos can be exploited, is 1,64,000 acres, therefore the gross yield comes to 38,54,000 tons, or working on a seven year rotation the sustained annual yield works out to 5,70,585 tons. In other words a far greater yield is available than would possibly be required by any one paper mill. A word of caution is necessary in connection with the figure 23·5 tons per acre which was obtained by weighing dry bamboos and by taking sample plots, the results of which are given in Appendix I. In the case of the 'Muli' bamboos the culms were absolutely mature, having produced seed and were therefore some 30 years or more old. Even then, were they only seven years old and not more than half the size of the culms measured, the figure of outturn would come to an amount far greater than that which will be required for a pulp factory of even large size.

7. *Lines of export.* —The lines of export are excellent, for rivers down which floating is possible occur everywhere and with the exception of the very small feeders they are suitable for floating throughout the year. The main streams are the Borak, Sonai and Kata Khal. The bamboos from the Upper Jiri Reserve can be worked out by the Jiri river and its tributary the Digli. The Lower Jiri Reserve lies along the Jiri river and is bounded on the south by the Borak. The Borak and eastern portions of the Inner Line and Sonai Reserves are tapped by the Sonai river, and its tributaries the Rukni and Punikhal. The eastern portion of the Line and Kata Khal Reserves are tapped by the Kata Khal and its tributaries Lalacherra, Guglacherra and Rupacherra.

It will thus be seen that the lines along which the raw material can be exported are plentiful and that floating is easy as the channels are sufficiently deep for floating rafts containing over 1,000 bamboos throughout the year. The obstructions in the shape of rocks or rapids are practically nil, though stumps of trees washed from the sandy banks of the rivers are to be found in fair numbers imbedded in the streams. These could, however, be extracted without difficulty, if found to break the bamboo rafts.

The lines of export from Badarpur are equally good, as not only is there a deep and open stream leading to the Brahmaputra on which steamers and boats can ply, but the railway also passes through the place, thus making import and export easy.

8. *Cost of cutting and extraction.*—The rate for "Muli" bamboo (*Melocanna bambusoides*) in normal times is Rs. 3 to Rs. 4 per 100 at Badarpur, now that most of this species has flowered and died the price is as high as Rs. 5-8 to Rs. 6 per 100. As the new shoots grow up the price will probably again drop to normal. Fine selected stems of "Dollu" (*Teinostachyum Dullooa*) fetch Rs. 6 to Rs. 7 per 100 at Badarpur.

The estimated cost of extracting "Muli" bamboos to Badarpur is put at Rs. 4 per 100 from the centre of the bamboo producing area. The figure is arrived at as follows :—

Cutting, Re. 1 per 100; dragging a distance of 1 mile, Re. 1-4 per 100; floating rafts, 8 annas per 100; floating to Badarpur, Re. 1-4 per 100. Cost of extracting "Dollu" bamboos will be slightly more as they are generally found further up the slopes, it may be put at Rs. 5 per 100.

9. *Cost of landing a ton of bamboos at the factory site.*—In this connection it has been assumed that both nodes and internodes can be utilized in the preparation of pulp. This assumption has been based on the recent experiments carried out by Mr. Raitt, the pulp expert engaged by the Forest Research Institute, and has since then been conclusively proved as possible on a commercial scale.

The figures of weight taken are those obtained from weighing carried out by the writer of the note when on tour in the Cachar Division.

Melocanna bambusoides, "Muli" bamboos.—The weight of 140 dry culms was found to be 1,503 lbs., so that it requires 209 dry culms to make a ton. The cost of 100 dry culms at Badarpur has been shown in section 8 to be Rs. 4 so that the cost of one ton dry "Muli" bamboos at the factory works out to Rs. 8-5-8.

Teinostachyum Dullooa or "Dollu" bamboos.—The weight of 100 dry culms was found to be 1,032 lbs., so that it requires 217

dry culms of "Dollu" to make a ton. The cost of landing 100 dry culms at Badarpur has been shown as Rs. 5 per 100, so that the cost of landing one ton of bamboos at the factory site comes to Rs. 10-13-7.

These figures are probably slightly too high for normal times and somewhat too low for the present, when "Muli" bamboos are short owing to their having flowered and died in 1910—12. It is estimated that it will take four to five years before the crop again attains anything like its normal state.

10. *Labour.*—Labour is very scarce and indifferent, it can be obtained in limited quantities for 8 annas a day, but it cannot be depended upon. As is the case with the tea garden labour in Cachar, it will have to be imported The tea garden agents recruit their labour from the C. P., Orissa and elsewhere and this is a special class of labour. For the purpose of cutting bamboos it will not be necessary to go so far afield for labour. Many people, chiefly Mahomedans, come from Sylhet to extract bamboos along the Borak, and, after paying royalty, sell them in the bazaars downstream. Similar labour could be procured to extract bamboos for a pulp factory, the men can earn 8 to 10 annas a day, and it is on this wage that the figures given in section 8 have been based.

11. *Firewood.*—Firewood is plentiful in these reserves and arrangements could probably be made with the Forest Department to allot areas for its extraction. It could be floated down to Badarpur and landed there at about Rs. 7* per ton, coal costs Rs. 14* per ton landed at that place.

12. *Chemicals.*—All chemicals will have to be imported by river to Badarpur with the exception of limestone which is obtainable from the Khasia Hills and brought to Sylhet for the preparation of the lime. It fetches Rs. 85* per 100 maunds in Silchar and somewhat less in Badarpur. It is also available from the Sibsagar Division.

13. *Miscellaneous facts.*—The forests are not very unhealthy except in the rains up till November when malaria prevails. The rainfall in these forests is about 120 inches per year, the

* NOTE.—These are pre-war figures which will have to be adjusted to present day rates.

Photo-Mech. Dept. Thomason College, Roorkee.

Photo by F. F. [illegible]

Melocanna bambusoides.

driest months being January and February; rain generally falls in April to the amount of 8 inches, while May has as much as 15 inches. The floating streams are all that could be desired except that the channels will have to be cleared of tree stumps. The only two difficulties which present themselves are the want of sufficient labour and the price of coal. The former difficulty can be overcome by importing labour, the latter is a more difficult problem and it will have to be ascertained before contemplating such a scheme how much firewood is available in order to save coal consumption

APPENDIX I.

Locality.	Area of sample plot in acres	Species: *Melocanna bambusoides* — No. of clumps	New culms	Old culms	No. of clumps	New culms	Old culms	Number of experimental culms cut.	Average length and mid girth of cut culms	Total weight green, in lbs	Total weight dry in lbs	Weight of dry internodes	Yield of dry nodes and internodes, in lbs. per acre. Total in lbs
		Mature culms											
Upper Jiri Reserve, Cachar Division (on small hill top)	½	Not found in clumps but singly, 3,261 culms counted			.	..	..	140	7.45" girth 29.8' length.	Not taken.	1,503 lbs	Not cut out	70,678 lbs or 31.2 tons per acre
		Teinostachyum Dullooa.											
Lower Jiri Reserve, Cachar Division	1	306	1,219	2,216	.	.	.	100	7.8" girth. 30'-7.9' length.	Do.	1,032 lbs.	.	35,449 lbs or 15.8 tons per acre.

Average per acre of two species together = 23.5 tons per acre.

(3) *Bamboo Area of the Langting Reserve in the Nambar Forests of the North Cachar Hill Tracts, Assam.*

1. A complete inquiry has not been made in connection with the possible exploitation of bamboos for pulp-making from this area, as the means of export and the relative position of the area to a possible factory site, together with other necessary factors, are not all that could be desired. The area was, however, inspected and the forests found to contain very large quantities of bamboos, so that were it found to be commercially possible to work the Borak and Kata Khal catchment areas in the Surma Valley, and therefore on the south side of the Cachar Hill Tract, it might later be found possible to work the Langting forests, lying on the north side of the hills and draining into the Assam Valley.

2. The forests drain into two large feeders of the Dyang river, namely, the Langting and Mupa streams. The former forms the northern and the latter the southern boundary of the reserve, while the western boundary is formed by the Dyang river. Floating is very difficult in the Mupa, while bamboos can be floated down the Langting stream during the rains, the Dyang being floatable throughout the year. As the Mupa stream is not available for extensive floating operations, the bamboos would have to be extracted from the neighbourhood of the Langting and Dyang rivers. This could be done from the reserve itself and also from the extensive unclassed forests outside the reserve. The total area thus tapped would be ample to supply even a very large pulp mill.

3. The disadvantage to this area for the purpose of extracting bamboos is the length of lead to a possible factory site, which would have to be in the neighbourhood of Lamsakhang station on the Assam-Bengal Railway or at Dyang Mukh where it joins the Kopili river, which flows lower down into the Brahmaputra. Other objections to working these forests are that they are remote from any village or town so that to obtain any sort of labour is almost impossible, while the locality is by no means a healthy one.

(4) *The Dangs Forests of the Surat Division of the Bombay Presidency.*

This report is based partly on a tour of inspection through the Dangs from Waghai to Bardipada, *viâ* Pimpri, Garvi, Mahal and Bardipada, in company with Mr. Hilley, the Divisional Forest Officer, in 1917, and partly on notes and reports compiled by Mr. Marjoribanks, who was for many years in charge of this Division.

1. *Description of area* :—The Dangs are divided into approximately three equal parts by the Khapri and Purna rivers, which flow parallel to each other, over winding courses in a more or less easterly and westerly direction. The configuration of the country is very rugged, being broken by irregular masses of high steep hills, thus rendering difficult the extraction of raw material from a large area to one point.

2. *Growth of bamboo.*—The bamboo is confined to the western half of the Dangs, that in the eastern half being negligible from the point of view of bamboo-pulp.

The predominating species is *Dendrocalamus strictus* which, according to Mr. Marjoribanks, comprises nine-tenth of the whole bamboo crop. The other species is *Bambusa arundinacea* which as far as has been seen is chiefly confined to the valleys and lower slopes. The *Dendrocalamus strictus* has flowered in the Southern Dangs and in many parts of the Central Dangs, while the *Bambusa arundinacea* flowered all over the Dangs some five to eight years ago and now forms a complete crop, which in some places is 30 feet high or more, though the general size of the bamboo is as yet less than this, especially in the south-west.

3. *Outturn* —No sample plots have been taken by the undersigned as the bamboos are in a transition stage, being either very young or over-mature and on the point of flowering. The only data available are from the sample plots taken in the North Dangs by Mr. Marjoribanks, and those he expressly states are in his opinion only a guide and cannot be accepted as final. He estimates that the number of bamboos available from exploitable areas is 35 millions, which by taking 250 dry culms *Dendrocalamus strictus* to the ton, represents 1,40,000 tons of bamboos. Taking the

cutting rotation at five years and only cutting half of each clump, this would mean 14,000 tons of raw material a year or at a 40 per cent. yield 5,600 tons of pulp. As these figures are based on the results obtained from a limited experimental area and also allow for no local demand, which amounts to approximately 2,000 tons per annum, a safe figure to take will be 8,000—10,000 tons of raw material per annum.

As regards the outturn there is one point, which requires serious consideration by the authorities and that is the expansion of the local demand in the future. Already the amount taken out annually on permit amounts to from 3 -5 lakhs of bamboos, while year by year the number so purchased is increasing. The prices paid is Re 1-8-0 per 100 or Rs. 3-12-0 per ton, so that it will have to be decided whether it is not more profitable to try and encourage the local market, sooner than sell what surplus there may be to a pulp factory.

4. *Proposed Factory site.*—The selection of a factory site is an extremely difficult one. As far as supplies of bamboos are concerned, the obvious selection would be either at Meskatri at the mouth of the Purna Valley or Chikar at the mouth of the Khapri Valley, of which the supply would be larger at the former place, but on the other hand the lead to the railway is some 17 miles, as against 3 from Chikar. Another alternative is to put the factory at Kalamba, the terminus of the railway, but this involves a longer lead for the raw material of both bamboo and fuel to the railway. Unai has also been suggested, but this place is out of the question, as it involves a longer lead by 10 miles, over very indifferent roads. The site, therefore, that is recommended is a spot close to Chikar village on the banks of the Khapri river, which is just inside the Dangs boundary, situated in relatively open country, 3 miles from the railway, with an ample supply of water, and supplied with bamboos from the western blocks of the Southern and Central Dangs and also, if required, from the western parts of the Northern Dangs, anyhow from as far up the Purna river as Kalibel and Chikhla villages. The idea of proposing Meskatri or the neighbourhood, as a factory site was

given up with some reluctance, and only because of its distance from the railway, combined with the fact that the Jankhari river would have to be crossed.

5. *Cost of extraction.*—Assuming that the site of the factory is at Chikar, the following are the distances from the chief centres where bamboos can be obtained:—

Waghai	to Chikar	...	...	6 miles.
Jarya	" "	...	...	3 "
Bhuripani	" "	...	...	6 "
Jaiwan	" "	...	...	4 "
Jhaura	" "	...	...	7 "
Jamunpara	" "	...	...	8 "
Meskatri	" "	...	...	14 "
Kalibel	" "	...	...	19 "
Tekpara	" "	...	...	22 "

To these must be added the average distance from the forest to the above-named centres which may be taken as about 2 miles. The average lead from the forest to the factory site, therefore, works out to about 10 miles

Based on the above distances the cost of extraction works out as follows:—

			Rs.	a.	p.
Cost of cutting 100 bamboos	...	...	1	0	0
Cost of carting " "	10 miles	...	1	4	0
Contractor's profits ...	...	...	1	0	0
Contingencies ...	...	...	0	4	0
	Total	...	3	8	0

The cost of extraction to the factory site for one ton = 250 bamboos, therefore, amounts to Rs. 8-12-0.

6. *Labour.*—Local labour is scarce and what is available is employed on existing forest work. It will, therefore, probably be necessary to import the labour, which is plentiful in the neighbouring districts. It will probably be found necessary to employ local cutting and extraction contractors who will make their own arrangements for labour.

7. *Lines of export.* There are good fair weather roads in most parts of the Dangs, but these are unfit for traffic during the monsoon months; some of these roads may require realignment in places and possibly bridging even for use in the fair weather, while a metalled road will have to be constructed over a length of three miles from Chikar to Kalamba, which is the terminus of the narrow gauge line, connecting at Billimora with the main line of the B. B. and C. I. Railway to Bombay.

8. *Chemicals.*—Mr. Marjoribanks states that 5,000 tons of calcite limestone are annually available from the Dangs, at somewhere about Rs 25 per ton.

9. *Fuel*—Fuel is available in considerable quantities at about Rs. 7-8-0* per ton and probably in this connection there will be no difficulty in obtaining supplies.

10. *Miscellaneous facts.*—The Dangs have a bad reputation as regards climate in the rains and no doubt with good reason, though in the fair weather there is nothing to prevent work going on smoothly. Chikar is virtually outside the Dangs and may be considered to have a moderately good climate.

(5) *Bamboo Areas of the Hoshangabad Division, Central Provinces.*

I was asked by the Hon'ble J. W. Best, Divisional Forest Officer, Hoshangabad Division, after having discussed the preliminary points with him in Dehra Dun in 1918, to visit his Division with the idea of utilizing bamboo and grass for the manufacture of paper-pulp and the inspection was carried out early in 1919.

The idea is to utilize the Sabai grass, which is at present exported to the Poona Paper Mills, together with bamboo for the manufacture of pulp, as Sabai is available in the district and also from neighbouring localities, while large quantities of bamboo are said to be available from the reserve forests.

2. *Description of the area*—The Sabai grass is obtained from the hill forests of the Hoshangabad, Chhindwara, Betul and

* These figures were taken in 1917 and will now require modifying.

Narsinghpur Divisions, while the bamboo will be obtained from the catchment areas of the Tawa and Denwa rivers in the Sohagpur and Bori ranges. The country is hilly, while the rivers themselves have a winding course and pierce the range of hills by a long gorge, with somewhat difficult rapids, down which it is not at present possible to float timber, though bamboos are floated from the end of the gorge downwards. The whole scheme depends largely on whether the bamboos can be floated down those rivers, after the obstructions in the gorge have been removed. It may here be mentioned that the amount of clearing required for floating bamboos is relatively small as compared with clearing it for the floating of logs.

3. *The supply of raw material available. Sabai.*—Sabai grass occurs in fair quantities in the Sohagpur and Bori ranges, also from the neighbouring Jagir lands. It is also available from the Narsinghpur, Betul and Chhindwara Divisions. The annual amount available is estimated to be as follows: —

(i)	Sohagpur and Bori ranges	...	720 tons
(ii)	Jagir lands ...	...	180 „
(iii)	Narsinghpur Division ...	...	360 „
(iv)	Betul and Chhindwara Divisions	...	720 „
	Total	...	1,980 tons or
	roughly	...	2,000 „ per annum.

Bamboo.—The question of supplying bamboo is not so much bound up in the number of bamboos available as in the number of carts available for extraction. Again, the site selected for the factory will, without doubt, affect the supply. There is another factor to be considered and that is whether bamboos can be floated down the Tawa and Denwa rivers to the factory. These points will be discussed later, in the meantime from an enquiry made there seems to be no doubt that 4,000 tons of bamboos can be obtained annually.

4. *Proposed factory site.*—Two alternative sites were proposed and inspected; one at Sohagpur and the other at Bagra, both on

the Bombay-Jubbulpore line and the latter also on the Tawa river. Sohagpur is a commercial centre for timber and in this connection is more suitable than Bagra, on the other hand Bagra, being situated on the railway and also on the floating stream, is obviously the better locality, especially as there is a most suitable site close to the railway, on the north bank of the river, somewhere near where the railway bridge crosses the Tawa river. There is water in the stream throughout the year which is amply sufficient to run a factory, while another great advantage is that it is a healthy locality, as the factory will stand on high ground. The lead by rail from Bagra to Itarsi is 17 miles and from Bagra to Bombay 481 miles.

5. *Lines of export.*—There are two alternatives, either to cart the grass and bamboos from the jungle to the factory site and to rail such grass as it is proposed to obtain from outside divisions or to cart the bamboos a short distance from the forests to the Denwa and Tawa rivers and then to float them down to the factory. The area is well served by railways as there is a main line from Bagra to Itarsi and thence a main line running both north and south.

6. *Cost of extraction. Sabai grass.*—

Locality.	Amount available in tons.	Cost per ton.
From Sohagpur and Bori ...	720 tons	Average Rs. 20-0-0.
From Jagir and Narsinghpur ..	540 ,, ...	,, Rs. 30-0-0.
From Betul and Chhindwara...	720 ,, ...	,, Rs. 30-0-0.
	1,980 ,, ...	,, Rs. 26-5-10.
Bamboos.—(i) By carts to a possible factory site :—		
From Sohagpur Range ...	1,000 tons	Average Rs. 12-0-0.
From Bori Range ...	3,000 ,, ...	,, Rs. 18 to Rs. 21.
(ii) Where floating possible :—		
From Sohagpur and Bori ..	*4,000 tons*	Average Rs. 9 to Rs. 12.

7. *Cost of producing a ton of unbleached pulp.*—(i) *Sabai unbleached pulp.*—The amount of raw material required to produce one ton of air-dried pulp from Sabai grass is 2·7 tons of grass, the average cost of a ton of Sabai grass is Rs. 26, therefore the cost of the raw material will amount to Rs. 70.

It requires 8 cwt. of caustic soda to reduce 2·7 tons of grass at Rs. 7 per cwt. (after recovering the caustic soda) or Rs. 56 a ton.

It requires a ton and a half of coal to deal with 2·7 tons of grass and therefore the cost of coal will amount to Rs. 22-8-0.

Labour may be put at Rs. 10 a ton, while fixed charges, depreciation, repairs, etc., are put at Rs. 20 a ton.

Abstract.

	Rs.	a.	p.
Raw material	70	0	0
Chemicals	56	0	0
Coal	22	8	0
Labour	10	0	0
Fixed charges, etc.	20	0	0
Total ...	178	8	0

(ii) *Bamboo.*—The amount of raw material required to make one ton of an air-dried bamboo is 2·2 tons. The cost of one ton of air-dried bamboo obtained by floating is Rs. 12, therefore the cost of 2·2 tons is Rs. 26-8-0. Otherwise the cost of boiling, chemicals, labour, etc., is approximately the same as that for Sabai.

Abstract.

	Rs.	a	p.
Raw material	26	8	0
Chemicals	56	0	0
Coal	22	8	0
Labour charges	10	0	0
Fixed charges, etc.	20	0	0
Total ...	135	0	0

8. *Fuel and chemicals.—(i) Fuel.*—It cannot yet be settled whether it would be more advantageous to use wood or coal. The cost of wood-fuel at Bagra is Rs. 5 a ton, while that of coal may be put at about Rs. 14 a ton. Generally speaking, about three tons of wood-fuel are equal to one ton of coal though of course the quality of coal and the fuel may somewhat alter this ratio, in any case the fuel, whichever is used, may be taken to cost Rs. 15 a ton.

(ii) Chemicals.—Soda will have to be imported, while good lime can be procured at Rs. 5 a maund

9. *Labour.*—Labour does not appear to be a great difficulty, though a larger quantity is available at Sohagpur than at Bagra, on the other hand there does not seem to be any real difficulty anticipated in collecting labour at the latter place. It is thought that labour will also be available in the forests for the cutting of the bamboos and grass. The greater difficulty anticipated is in obtaining a sufficient number of carts and for this reason, if no other, floating the bamboos is a very important point.

10. *Market for the pulp.*—As regards the quality of the pulp obtained from Sabai grass, there is no question whatsoever that it is of a high grade and will always find a ready market in the Indian paper mills The bamboo available is *Dendrocalamus strictus*, tests with which have been carried out on a commercial scale and this species has been found to yield a good quality pulp. The quality of Sabai pulp is better than that of any bamboo, while bamboo pulp is placed equal to, if not better than, imported sulphite spruce. Paper-makers, who have had experience with bamboo pulp have no fear whatsoever as to not being able to make a really good paper from this material. It therefore follows that it is unnecessary to carry out further experiments to test the quality of the pulp available either from Sabai or bamboos. As regards markets for the pulp, a portion could probably be disposed of in the Bombay Presidency and the rest in Calcutta or Northern India.

Another point to be considered is the proposed capacity of the mill. The raw material amounts to 2,000 tons of grass and

4,000 tons of bamboo which will yield 2,500 tons of air-dried pulp, and until more is known as to outturn, it would not be safe to anticipate a mill of greater capacity than that mentioned above.

As regards the price of bamboo pulp, it is not possible to estimate what will be the price during the next decade. The only possible means of gauging the value of pulp is to take pre-war prices of imported sulphite spruce and Sabai pulp. The pre-war prices of imported unbleached spruce pulp were Rs. 150 to Rs. 155 a ton and of Sabai Rs 190 a ton, at these figures it would be just profitable to make Sabai and bamboo pulp. Though the war is over, and prices are still extremely high, they will no doubt come down, and in the best informed quarters it is anticipated that imported sulphite spruce will never again be available at less than Rs 195 per ton. Under the circumstances were a pulp to be prepared, made of one-third Sabal and two-thirds bamboo pulp which would be of distinctly superior quality to sulphite spruce, it could be produced at the same price as imported pulp based on pre-war rates and Rs. 45 per ton cheaper than the estimated post-war rates. It will be understood that the above are extremely conservative figures, when it is stated that sulphite spruce pulp is at present fetching from £50 to £60 per ton in England.

11. *General remarks.*—The above note is only a very rough outline of a possible scheme for the manufacture of pulp in the Hoshangabad Division. Much more information is required before any definite scheme can be framed. The two most important points to be settled in the near future are:—

(1) The possibility of floating bamboos from Bori down the Denwa and Tawa rivers and (2) to obtain more definite information as to the cost of landing bamboos at the factory site from the Sohagpur and Bori forests. The position of Sabai is much more definite, while the mere fact of having as much as 2,000 tons of Sabai grass to mix with the bamboos makes the whole scheme a much more attractive one. If any one becomes interested in this question and wishes to go further into the matter,

his first business will be to obtain expert opinion as to the possibility of clearing the floating streams and also to obtain estimates of cost for plant, capable of producing 2,300 tons of pulp annually.

ANJAN (*HARDWICKIA BINATA*) COPPICE

As promised in my article published in the June 1918 mumber of the *Indian Forester* I now give further details of experiments in connection with Anjan coppice. The publication of the results has been delayed owing to my having been on leave.

The Anjan forests of the Shirpur East Range of the North Khandesh Division are worked under the coppice with standards system, and after the standards had been marked in 1917 in the current exploitation coupe No. 20 of Block III (which was unfortunately somewhat thinly stocked) twelve one-acre plots were marked off. The unreserved trees were then felled in one plot per month beginning with April 1917 and ending with March 1918, the fellings being made in the first week of each month. In each of these plots one-fourth of the area was cut over at ground level, one-fourth at 6", one fourth at 12" and one-fourth at 18" from the ground. The resulting coppice and pollard shoots in all plots were measured in November 1918 and details are summarized in Tables A and B below. Table A gives the girth at breast height and time when fellings took place, and below the number of trees felled in each monthly plot is shown the number of trees which failed to reproduce themselves by means of coppice or pollard shoots. In this table I have not shown the heights at which the trees were felled above ground-level as it would have made the Table too complicated. Table B shows the heights of stools in all the monthly felling plots, and further shows the numbers which failed to reproduce themselves in each class, and the average height of the shoots from the *stool* level of all those trees which did reproduce themselves.

TABLE A.

Anjan coppicing power in relation to *girth* and *season* of felling.

Month of Felling.		Girth (inches).												Total trees.	Percentage of failures.
		12-24	25-30	31-36	37-42	43-48	49-54	55-60	61-66	67-72	73-78	79-84	85 and above.		
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1917 April ...	Felled ..	15	10	6	3	2	..	1	1	...	...	.	...	38	...
	Failures	1	0	0	0	0	..	0	0	..	...	...	..	1	3
May ...	Felled ...	3	3	6	6	9	1	2	..	...	1	.	..	31	...
	Failures ...	0	0	2	1	1	0	0	-	-	1	...		5	16
June .	Felled ...	7	5	8	2	3	4	1	1	4	..	2	...	37	..
	Failures ..	1	0	1	0	0	1	0	0	1	...	1	...	5	14
July ...	Felled ...	6	6	4	5	1	3	1	1	1	1	.	2	31	
	Failures ...	0	0	0	1	1	1	1	1	0	0	..	0	5	16
August ..	Felled ...	29	10	4	3	2	..	2	..	-	.	..	...	50	.
	Failures ...	0	0	1	1	0	..	1	...	..	..	..	..	3	6
September..	Felled ..	28	14	10	1	1	1	1	1	.	...	...	...	57	3½
	Failures ...	0	0	1	0	1	0	0	0	...	...	..	...	2	...
October .	Felled ...	34	7	2	4	4	4	4	1	1	...	..	...	61	.
	Failures ...	0	0	0	0	1	0	1	0	1	...	...	...	3	5
November...	Felled ...	23	6	2	1	3	1	..	..	1	...	...	1	38	.
	Failures ...	1	1	0	0	0	0	...	...	0	..	...	0	2	5
December ...	Felled ...	2	1	5	...	1	3	3	2	..	.	...	...	17	...
	Failures ...	0	0	1	...	0	0	1	0	...	..	...	...	2	12
1918 January ...	Felled ...	1	3	2	1	2	6	3	1	..	...	..	1	20	..
	Failures ...	0	0	1	1	0	0	1	0	...	...	-	0	3	15

February...	Felled ...	10	13	9	4	8	5	3	..		...	..		52	
	Failures ...	0	0	2	0	0	0	0		.	.	.	.	2	4
March ...	Felled ...	27	6	9	4	10	2	5	..		..		...	63	
	Failures ..	3	0	1	1	3	2	0	.		.			10	16
Totals ...	Felled ..	185	84	67	34	46	30	26	8	7	2	2	4	495	.
	Failures .	6	1	10	5	7	4	5	1	2	1	1	0	43	9
	Percentage of failures.	3	1	15	15	15	13	19	13	29	50	50	0	9	.

TABLE B.

Anjan coppicing power in relation to *height* of stool and *season* of cutting.

Month of felling.	Height of stools: 0": Trees felled.	0": Failed to coppice	0": Average height of coppice shoots from stool level	6": Trees felled	6": Failed to coppice	6": Average height of coppice shoots from stool level.	12": Trees felled	12": Failed to coppice.	12": Average height of coppice shoots from stool level.	18": Trees felled	18": Failed to coppice.	18": Average height of coppice shoots from stool level.	Totals: Trees felled	Totals: Failed to coppice	Average height of coppice shoots from stool level
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
			(feet)			(feet)			(feet)			(feet)			(feet)
1917															
April ...	3	-	1	26	1	¾	7		1	2		1	38	1	1
May ...	4	3	1½	8	1	½	11	1	¾	8		1	31	5	1
June ...	10	4	1	4	-	1	11	1	1	12		1	37	5	1
July ...	5	3	¾	5	2	1½	9	...	1	12	.	2	31	5	1¼
August ...	7	2	1¼	14	1	1½	16		¾	11	..	3½	50	3	2¼
September	7	..	1½	16	2	1¼	14	..	1½	21		2½	57	2	1¾
October ...	26	2	1¾	22	1	2⅓	6	.	2¾	5	..	3	61	3	2½
November ...	7	.	1½	9	1	2¼	12	1	3¼	10		¾	38	2	2
December...	4	2	1	6	0	2½	3	...	1¾	4		1½	47	2	1¾
1918															
January ...	2	...	¾	2	..	¾	9	3	1¾	7	.	1½	20	3	1¼
February ...	6	...	1¼	7	1	1¼	21	1	1½	18		1½	52	2	1½

March ...	10	4	¾	17	5	1¼	21	1	2	15	...	1	63	10	1¼
Totals ...	91	20	...	136	15	...	143	8	...	125	...	...	495	43	...
Percentage of failures.	22		..	11		...	6		...	0		...	9		
Average height of coppice shoots.	..	...	1¼	...	...	1⅔	...	...	1¾	—	...	1⅔	...	..	1⅔

From Table A, Column 16, it seems that season of felling has little to do with the power of coppicing, but if any period is better than another perhaps it is from August to November (inclusive, *i.e*, the end of the rains and beginning of the cold season; and the worst season May, June, and July, *i.e.*, at the end of the hot season and the beginning of the rains. From the bottom line of the same table it appears that there is but little relation between girth and power of coppicing in the case of trees over 30" in girth. The results of this experiment confirm the conclusions arrived at after the first experiment. The conclusions would have been more certain had there been more trees in the larger girth classes, *i.e.*, above 60".

From the last line but one of Table B it will clearly be seen that height of felling has a marked influence on reproductive power, there being 22 per cent. of failures in trees felled at ground level, only 6 per cent in trees felled at 12" from the ground, and *no failures* whatever in the case of those trees which were felled at 18' from the ground. From the last line it will also be seen that trees felled from 12" to 18" from the ground yield the most vigorous shoots. From Column 16 it will be seen that the most vigorous shoots are formed from the stools of August-November (inclusive) fellings. Table A shows that this was also the period of felling which yielded least failures.

From these experiments it may therefore be concluded that for fuel coupes it is better to pollard at 18" from the ground but that season of felling matters little although there seems to be a little evidence in favour of felling at the end of the rains and during the early cold weather. Very large trees coppice somewhat poorly but they are scarce.

H. W. STARTE, I. F. S.,
Divisional Forest Officer,
Belgaum.

BELGAUM
12th July 1920.

ERYTHRINA GLABRESCENS SP. NOVA.

Erythrina glabrescens = *E. suberosa*, Roxb., var. *glabrescens*, Prain in Journal, Asiatic Society of Bengal, LXVI, 2, p. 410. This plant occupies a position intermediate between *E. suberosa*, Roxb. and *E. arborescens*, Roxb., being nearer the former than the latter from which it is easily distinguished by the pod. It is a larger tree than *E. suberosa* reaching 50—60 feet in height by 5—6 feet in girth and has nearly smooth reddish bark very distinct from the rough corky bark of *E. suberosa*. The mature leaflets in *E. suberosa* are densely pubescent beneath, in *E. glabrescens* glabrous or very nearly so when fully mature and they are glabrous in *E. arborescens*. In the three species the standard is respectively 3—4, 2 and 2—3 times as long as broad. The seed in *E. suberosa* is a dull pale brown, in *E. glabrescens* bright red and polished.

I have long suspected that the tree cultivated in gardens in N.-W. India under the name "*E. indica*" is a distinct species and identical with Prain's *E. suberosa* var. *glabrescens* but could not be quite sure of this as it is difficult to find a specimen of the wild tree big enough to make a fair comparison of the bark. This I have only recently been able to do in the Ravi valley. In the plains *E. glabrescens* does not fruit so that the seed cannot be compared. In Dehra Dun, however, the fruits set and would doubtless ripen if the trees were not stripped by parrots. I have picked up nearly ripe pods under the trees showing bright red shiny seeds as in the wild tree and am now satisfied as to the identity of the two.

That it is a good species and sufficiently distinct from *E. suberosa* would not I think be denied by any one seeing the two side by side. The differences between them are analogous to the differences between *Terminalia Arjuna*, W. & A., and *T. tomentosa*, W. & A. No one knowing these two trees in the field can doubt that they are different species and yet Clarke in Flora of British India, II, p. 448, although treating them as distinct suggests that they may not be. Moreover specimens of *E. glabrescens* showing flowers and mature leaves might easily be taken for *E. arborescens*.

E. glabrescens is indigenous to the Ravi and Sutlej valleys at 2,000—4,000 feet, exceptionally occurring at greater elevations. It is also indigenous in similar places in the United Provinces. in the Punjab, in the Sub Himalayan tract and in the Siwaliks it appears to be completely replaced by *E. suberosa*. On the outer slopes of the Himalaya at about 3,000 feet I have seen both species planted in hedges or on roadsides and both may be indigenous or both may be introduced. As a wild plant *E. glabrescens* is almost always small and shrubby owing to shallow soil but when planted reaches a fair size though not reaching the dimensions often seen in the plains. As a cultivated tree in the Punjab plains it is found in all large stations being the only species of Erythrina which reaches the dimensions of a fairly large tree. It is also grown in Saharanpur and Delhi and was probably introduced to cultivation through the Botanic Gardens, Saharanpur.

R. N. PARKER, I.F.S.

CHAMBA:
1*st October* 1920.

A QUESTION OF PADLOCKS.

I have just written a letter to my Conservator pointing out that I am his most obedient servant, and asking his permission to purchase a padlock.

The necessity for having to do this has come as a distinct shock to me I have been a truant from Divisional work for several years, having been employed on a special job. My recollections of the ordinary routine of a D. F. O.'s life are somewhat hazy, but I well remember making merry with my friends over the fact that keen-witted young Forest Officers, possessed of an average amount of honesty, could not be trusted to buy a padlock without their Conservator's permission.

My first flush of youth, alas, has gone, and my hair is turning grey. Advancing years have, however, their compensations, and one of these, as a rule, is increasing independence and freedom from

that somewhat irksome control to which hot-headed youths are compelled to submit. I do not think I am really dishonest. I have even had young men, all of them potential padlock buyers, entrusted to my care by a confiding Government to be trained up in the way that they should go. And yet I cannot but feel that I have not yet succeeded in winning the full confidence of my Chiefs, for, I repeat, I have just had to write to my Conservator asking to be allowed to purchase a padlock.

From the draft which my Head Clerk has put up I see that there are other things beside padlocks which I cannot be trusted to buy on my own responsibility. A bucket, a tape and a lantern are also apparently articles the very sight of which are likely so to excite my cupidity that were it not for the restraining influence of my patient Conservator, I should buy them by the gross. My Head Clerk tells me that I may not buy these because they are classed as Office Furniture. Were I an unprincipled spend-thrift I might, he tells me, squander Rs. 200 on pickaxes or saw, mills or timber-slides, and snap my fingers in my Conservator's face. But I do not want pickaxes, and I do not fancy I should get much of a saw-mill or a timber-slide for Rs. 200. I do, however, want lamps, I want tapes, and, above all things, I want padlocks. A padlock is such a necessary thing. Even as I write I notice an evil looking person furtively eyeing the door of my office, and looking as if he were only waiting for the staff to leave in order to burst in and satisfy his literary cravings by having a read of the Forest Department Code or revive his jaded spirits with some of the other intellectual tonics which fill my shelves. Poor fellow, his yearnings will remain unsatisfied. Why so, you ask? Because there will be a padlock on the door! Yes, padlocks are necessary things; without them life in India would be insecure indeed. It is for this reason that, putting my pride on one side, I have humbly written to my Conservator craving his kind permission to purchase a padlock.

I am glad to say that the Division of which I am taking charge is a newly formed one, or, in other words, a Division in which there have never before been any padlocks.

Otherwise I should have to answer various queries from the Conservator's Office as to why I wanted a new padlock, what had happened to the old one, on what date it had been purchased, whether it could not be repaired and, if not how it was to be disposed of. Under the present circumstances, however, I do not see how the Conservator can refuse his permission. He may perhaps object to the number I have asked for, for I have summoned up sufficient courage to tell him that I want several He may possibly point out that if I were to arrange for my Clerks' Office to be in the same room as my own private office there would be a saving to Government of the cost of one padlock. He may, I say, do this, but I have an inkling, call it second sight or what you may, that my Conservator is going to sanction the purchase of at least one padlock.

I met him at the Club the other evening, and, in jocund mood, I told him that I had that day written to ask him if I might purchase a padlock. He said it was a farce and I agreed with him, but on reflection it seems to me that it is more like a tragedy. They say there is a paper shortage, but think of the reams of paper wasted in India by innumerable officers writing innumerable letters to innumerable other officers asking to be allowed to buy padlocks and innumerable other things as well. Think of the thousands of envelopes required to enclose these letters, and the gallons of ink used, nay wasted, in writing them. Think of the immense number of stamps necessary for, and the cost of the carriage of, these letters. Think of the wear and tear of typewriters, and many other things besides. But think most of all of the appalling waste of time.

I shall lie awake to-night wondering what would happen to me if I were inadvertently to buy a padlock without permission. What would the Accountant-General say? What would the Conservator say? I shudder to think. Having outraged the financial sense of the former and flouted the authority of the latter, I should have a sorry time, and the least penalty imposed would probably be the deduction of the cost of the padlock from my pay in not more than three instalments. But what if I went further still?

What if deliberately, in a fit of madness (or might it not be of sanity)? I were to throw discretion to the winds and exclaim "I consider a padlock to be necessary, I refuse to waste Government paper and ink, as well as my own time and that of my clerks, in asking for permission to buy it; I consider my own judgment in this matter to be as good as my Conservator's or anybody else's; I will, therefore, purchase the padlock, and if any letters of remonstrance come from higher authority I will tear them up!" But stay; pure Bolshevism could hardly go further, and a course of this kind could lead but to one result. I should assuredly have an opportunity of verifying in the most practical manner possible the truth of the statement I see in the press that the homeward passage rates have once more been increased.

Can nothing be done, I ask in all seriousness, to give D. F. Os. some power in this matter? Under section 70 of the Forest Department Code, D. F. Os. may sanction expenditure up to Rs. 200 on certain items, and under section 69 Local Governments are authorized to increase this amount in the case of selected officers. Neither section however gives D. F. Os. any power to spend a single pie on the purchase of livestock, furniture, or tents. Why is this? Surely the D. F. O. is the best judge of what furniture he requires? He is not likely to hang his office with tapestries or to provide his clerks with luxurious ottomans. Nor is it likely that his requests are so unreasonable that the Conservators have often to refuse them. No; the sole practical result of debarring D. F. Os. from purchasing anything which is classed as office furniture is the increase of office work. The time spent by clerks in India in registering correspondence of this kind must alone amount to a considerable period yearly. Can nothing be done to alter this state of things? The appointment of Chief Conservators must have brought the Department into much closer touch with Government than formerly. Can they not represent the matter? Will not our present Inspector-General, who has done so much for the Department, tackle the Government of India on the subject, and so win the gratitude of countless generations of long-suffering, padlock-buying, D. F. Os?

All men have I suppose, whether consciously or unconsciously, an aim in life. Some, careless of what their present lot may be, strive only for the highest ideals. Others make money or position their goal. A goodly number in this land of exile think only of the day when, having scraped together sufficient money to take a passage home (second class B accommodation), they will leave the Shiny East for ever and spend their declining years in the bosom of their families. For myself I feel I shall never taste the full flavour of the wine of life until that day dawns when I can boldly march into the bazaar and buy a padlock without my Conservator's permission.

J. D. M.-K.

NOTE.

The Honorary Editor will be glad to know of any reader of "The Indian Forester" who will undertake the work of reading and abstracting anything of value from the technical foreign books and journals (principally of forestry) in such of the lesser known languages as Italian and Dutch.

EXTRACTS.

COLOURED WOODS OF INDIA.

The Timber Trade Exhibition arranged by the Department of Overseas Trade, which was opened at Holland Park Skating Rink on 5th July and which the Department has agreed to keep open for a further week, has done much to increase public interest in the reafforestation, not only of Great Britain, but of the whole Empire. Many beautiful and useful woods in various stages of manufacture are displayed, and some idea of the extent of the exhibition is given by the fact that over 600 different varieties of wood are to be seen.

The exhibit which attracts most attention is that of the Indian Empire. India possesses alike in its plains, hill country and the mountainous region of the Himalaya, a wealth of timber

trees, the value of which, though probably unsurpassed in any other country in the world, is almost unknown and unrecognized commercially in the United Kingdom. Of the 100 specimen exhibited only one—'Padauk'—has hitherto been seen or used in England. It would require an expert to describe the beautiful timbers and the uses they have been put to, but a passing reference to a few may give some idea of their beauty and suitability for ornamental purposes. The Indian tulip wood of a soft rose-pink colour, tinged with streaks of mauve or purple, is used in the manufacture of small fancy work. Indian yellow heart, used for the manufacture of chairs, is of a bright orange yellow colour with darker shades, and is remarkable for a certain opalescent translucency.

TREES FROM SUN-STEEPED FORESTS.

Only the luxuriant sun-steeped forests of the tropics could produce a wood of such rare and handsome colouring as laurel wood, which is of a golden to greyish brown colour, with deep streaks and markings of a dark amber shade. Andaman marble-wood, hard, smooth and cold to the touch, glossy and lustrous when polished, resembles marble to a surprising degree. The valuable European walnut finds a counterpart in the black walnut of India, although it is somewhat darker than the European wood. Of a bright amber shade, haldu possesses also a particularly smooth close texture, and can be used as a substitute for satin-wood. It appears to advantage in carved mouldings for fine decorative work and has a distinctive appearance in brush and mirror backs. In striking contrast to the quiet browns and greys of so many timbers is the brilliant crimson to vermilion Andaman padauk. It is difficult to imagine a more handsome or effective wood for cabinet work and all decorative purposes. As parquet flooring it presents an excellent appearance. Burma greenheart is a brilliant bronze to orange yellow in colour. Indian rosewood, as its name implies, is of a rich roseate to purple hue, with deep sable streakings. Gurjun is of a mellow golden-brown colour, and when cut on the quarter displays the dappled lights of a silver grain. Sissoo is a member of the rosewood family, which ranks

high as a furniture wood, and Indian silver greywood is rapidly taking the place in cabinet making of harewood or concha satinwood of San Domingo, which since the 17th century has been sought for on account of its delicate grey colour and satinlike lustre. The woods from India are shown in all stages from the raw timber to the most highly polished article. Mr. Howard, who has charge of the exhibit, states that these woods are available in very large quantities. At the moment there are only limited supplies in England, but the timber is coming over as fast as shipping space can be found.—[*The Times*, 17th July 1920.]